CURRENT SCIENCE

Vol. XII] JUNE 1943 [No. 6

	PAGE
Paddy-Cultivation cum *Fish-Culture.* SUNDER LAL HORA	169
The Economic Aspects of State Geological Surveys. BY CYRIL S. FOX ..	173
Scientific Discovery.	175
The Origin of the "Rohr" or Anhydrous Sodium Sulphate Beds below the Salt Pans at Didwana. BY E. SPENCER ..	176
Nephridia of Earthworms. B. P. ..	180
Sir Cyril S. Fox, Kt.	181
Dr. C. G. Pandit, O.B.E.	181
Dr. J. J. Rudra, M.B.E.	182
Diwan Bahadur Dr. K. R. Ramanathan ..	182
Letters to the Editor	183
Reviews	190
Centenaries—	
Gill David (1843-1914)	193
Science Notes and News	193
Errata	196

PADDY-CULTIVATION *CUM* FISH-CULTURE

SIR F. A. NICHOLSON,[1] in his 'Note on Fisheries in Japan', described how Japan was utilising its paddy fields for the culture of carps. He observed:

"The distribution of fry is gratis and is for a special purpose; in Japan it is customary in suitable localities to place young carp when one or two inches long, in the paddy fields in June when irrigation begins; by October, say four clear months, when the paddy is cut these have grown to 8 or 10 inches and are quite marketable; the rapidity of growth is due to the warmth, excellent feeding on minute crustacæ such as copepods, larvæ, etc., in the fields, from which, of course, they are kept from escaping by bamboo gratings. Should the water in the fields fail, the ryot digs a small pit in one corner in which the fish can survive till more water comes down. The rearing of the fish in the fields is said to improve the produce of the paddy since the fish destroy many insects injurious to the plant." (Pp. 86-87.)

He further observed:

"On the subject of the growth of carp in paddy fields Prof. Mitsukuri says that in a single village the agricultural society (a point worth noting) represents the *whole* village, utilises 250 acres of paddy fields each year for this by-product, and annually breeds 25 million fry to be sold and raised in surrounding villages. He mentions another case where a vast area is irrigated (as in Egypt) by inundation, and the culture of carp in this area, though in its infancy, realised in 1902 no less than Rs. 72,000." (P. 87.)

In making suggestions for the improvement of fisheries in India, Nicholson (pp. 100-101) regarded paddy fields as suitable grounds for fish culture, especially in the deltas where the water-supply is almost unfailing. Thus vast areas of Bengal are particularly suited for the simultaneous cultivation of paddy and the culture of carps.

In considering the question of paddy *cum* carp culture, it is essential to remember that though the yield from individual fields may not be great, the aggregate produce would run into several millions of pounds. This experiment can be conducted at practically no cost except that of obtaining the fry, while if villages do so on an extensive scale on co-operative basis, thereby reducing the individual expenses, the income from this by-product would be considerable. Mitter[2] has calculated that if the acreage in Bengal under rice crop (2,292,100 acres) and jute crop (2,310,300 acres), which require water almost all the time during the season, were to be utilized for the culture of fishes and if the average yield from the fishery were to be calculated at a modest sum of Rs. 10 per acre an annual additional income of nearly 5 crores of rupees could be derived from these sources.

In his popular note on 'Carp-Growing in Germany', Nicholson[3] made reference to this subject again and suggested the culture of carps in the vast areas covered by paddy fields in Madras.

Though references to the great possibilities of paddy cultivation *cum* carp culture are contained in the writings of several later writers[4] on Indian fisheries, no one appears to have recorded this practice from

any part of India. It is a matter of great pleasure, therefore, to report that in parts of the Sundarbans use is being made, though at present to a very limited extent, of the paddy fields and khals in the Abad areas for the culture of common Indian carps. Before describing the practice as prevailing at present, it is necessary to say a few words about the genesis of the Abad areas.

It has long been realised that detaic action has given rise to a network of deep creeks in many areas in South Bengal, particularly in the Sundarbans. In view of the heavy rainfall and the rise and fall of the spring tides in these regions, a network of deep khals is developed for the draining of the receding waters. In the process of colonisation, it is necessary to make embankments right round the area to be colonised so as to prevent the salt-water flooding the land. For this purpose a number of creeks are also dammed across by massive bunds (embankments). These creeks are sometimes over 25 feet deep, 100-200 feet broad, and several miles long, and by putting in sluices at the river end they are used as drainage canals for the embanked areas. Certain low parts of the embanked land are flooded with salt water and the young of river fish are taken in and allowed to grow for 8 to 9 months till they attain a marketable size. Then about November-December, the fishery is de-watered and the fish are either trapped or netted. Gradually when the higher lands in the embanked portions lose a part of their salinity through the action of the rains, and this happens in two or three years' time, they are put under paddy cultivation. So at one stage the *khals* with brackish waters are used for the cultivation of salt-water fishes while the neighbouring fields properly embanked are used for paddy cultivation. With the salt-water fisheries there is always a danger to the embankment, for snakes, eels, crabs, etc., cause immense damage by tunnelling through them. To avoid this heavy loss month after month, the brackish water fisheries are usually discarded and more lasting embankments are put up for the collection of fresh water. Not very long ago these creeks or drainage canals were not utilised in any way though the fields alongside them were used for the cultivation of paddy.

I am informed that about fifteen years ago, Babu Priyanath Sao of Suryapur, now living in Gurguria, while on a visit to Midnapur, where the carp fry are available in abundance, happened to purchase eight annas worth of very young fry and brought them to his place in the Sundarbans in a small pot. These he liberated in a small pond near his homestead and when the fry attained a size of about two inches, he transplanted them into another larger pond. These were liberated in the month of Asar and Sraban (July and August); when ten months later, he caught those fishes, to his great surprise Catla had attained a size of about seven seers, and Rohu about five seers.[5] This encouraged him very much and the news spread all over the neighbouring Abads and the people then thought of seriously taking up carp culture as a profitable proposition in their creeks alongside the paddy fields. Now these fish are cultured in several of the creeks and it has been reported that they have bred naturally in some of these canals. However, the dealers in carp fry now go from Abad to Abad during the stocking season and the people are taking to carp culture as a subsidiary means of making some extra money. It is a pity that the evil practice of stocking fishery areas with very young fry is also prevalent in these Abads and in some cases, therefore, the results are not very satisfactory. For the present only tanks and ponds are generally stocked but in certain cases these are connected with paddy fields during the season so the fishes roam about over vast areas.

The breeding of carps in these estuarine parts of Bengal may seem rather strange, because from the information so far available carps have only been known to breed in large rivers with swift currents during floods when the neighbouring paddy fields are covered with flood-waters and the brood fishes leave rivers and enter the shallow and warm waters.[6] As indicated above, the deep creeks in the cultivated areas in the Sundarbans and the high lands where the paddy fields are situated, provide an exact parallel to the conditions which prevail in the artificial breeding grounds of carp in places like Midnapore[7] and Chittagong.[8] There is every probability, therefore, that the carps may have bred in these parts, though it has not definitely been ascertained so far.

From the rate of growth and the ease with which these fishes have been cultured in

these parts, it seems evident that there is a great possibility of developing carp culture in the Abads. As it is a relatively new venture in these parts, it is essential to organise it along proper lines. In the first place, it must be made clear to all pisciculturists to stock their tanks only with fry of reasonable size so as to avoid the introduction of predaceous fishes, such as Boal, Saul, Chital, Phaloi and others. It was brought to my notice that in one of the tanks, where inadvertently a Boal had been introduced, out of about 15 seers of fingerlings only thirty carps were netted, while a Boal of about 4 to 5 feet long was also taken from the tank. This explained the cause of failure of this crop of carps.

With regard to the rapid growth of fish in these waters, it must be remembered that in the beginning, when the water is slightly brackish, there are plenty of shrimps, prawns and abundance of planktonic organisms, and Catla and Rohu feeding on them grow at a fairly rapid rate. When the water becomes almost fresh, then vegetation appears which consists of water-lilies, Samna grass and various types of Jhanjis and Panas. However, the growth of the fishes is not to be ascribed only to the abundance of food but also to the long runs they have in the creeks and the adjoining paddy fields which generally swarm with microscopic life. Thus in the Sundarban Abads we have extremely favourable conditions for paddy *cum* carp culture.

At the time of paddy harvesting it is necessary to dewater the paddy fields and at this time either the fishes are marketed or they are allowed to congregate into the deeper channels or the creeks referred to above. After the paddy is harvested, the dry season having commenced, the lands are left fallow for the cattle to graze on while in suitable areas vegetables or other short-term crops are raised.[9] On the rush of monsoon all cattle refuse in these dry portions is carried into the deeper channels and provides manure for the growth of fishes. In pisciculture it has been found necessary to allow piscicultural areas to dry up and as noted above in these Abads this is almost a necessity at the time of harvesting paddy. It will thus be seen that most ideal conditions exist in these Abad areas for the cultivation of paddy and the culture of carps simultaneously.

Attention may here be directed to the practice of prawn culture in paddy fields along the Malabar Coast in North Travancore.[10] The paddy fields adjoining the backwaters and at a somewhat higher level are cultivated only once in the year from July to October when the water in them is fresh. The paddy is harvested by about the end of September and then the same fields are used for the culture of prawns. The flooding caused by the October-November rains is often allowed to keep the backwaters in direct communications with the paddy fields, but after the monsoon and with the lowering of the water-level the communications are restricted and during high tides brackish water, along with the young of prawns, is allowed to get in freely through sluice gates in the embankments into the paddy fields. By judicious manipulation fresh water is drained out occasionally and brackish water taken for some months into the paddy fields so the salinity of the water in the paddy fields goes on raising. The fishing for the prawns starts after two to three months of stocking (end of December or early in January) and lasts for several months. The rains of the south-west monsoon wash out the salinity from the fields and make them suitable once again for paddy cultivation by about July.

In places where "Bhasa Bada" fisheries in the Sundarbans adjoin paddy fields or fresh-water canals, mullets and prawns, especially Bagda Chingri, are allowed access into fields and canals for they are known to fatten well under fresh-water conditions usually in the second year of their growth.

Mr. H. S. Majumdar, Agricultural Officer, Gosaba (24-Parganas), has kindly made the following suggestions from his practical experience.

In suggesting the cultivation of fish along with paddy, attention may also be paid to the following important factors:—

(*i*) Owing to the continuous movements of the fishes, planted in the paddy fields, the tillering action would be increased due to disturbance of the mud and the weeds. As is well known, Carps eat Jhanjis, other soft weeds and the insects which drop from the crops due to their movements or by the breeze.

(*ii*) The paddy crops benefit from the excreta of fishes, which serves as manure.

(*iii*) Due to the sound from the paddy crop caused by the movement of

the plants and by the breeze, fishes run about which is healthy for their growth.

If the fish thus reared as a by-product are sold in the month of October, that is, after four months of cultivation, at least fifteen times profit on the purchase value would be made. But if the fish are transferred to a big pond, or if trenches are dug around the paddy fields and the fish preserved in them for a longer period, much greater profit could be made.

The cost of digging trenches in the Abad areas is negligible in comparison with the benefit that would be derived from stocking fish in them. The earth excavated for making these trenches would serve the purpose of making strong bunds. These bunds can be utilized for high land crops, vegetables and other trees which would provide the cultivators with another means of earning and also control the water in the fields which would be helpful for cultivation of crops and fishes.

The trenches could be utilized as reservoirs for the irrigation of vegetable and paddy crops, when necessary. They can also be used to drain out water from the fields, if required, and would not allow the field rats, cattle or thieves to enter the fields and cause damage to the paddy crops.

These trenches would serve as places of retreat for the fishes, and can also be used for the cultivation of deep-water 'Aus' and 'Aman' paddy.

The bunds would prevent the wasted away silt to get deposited in the trenches. The bottom mud from the trenches would serve as a good manure for paddy fields.

The trenches if covered by bamboo shades, may be used as support for the creeper vegetable plants, such as kumra, cucumber, etc.

The poor cultivators may take advantage of these suggestions by mutual co-operation if they find it hard to do it individually.

In a recent communication, Dr. Herbert H. Brown, Director of Fisheries Investigations, British West Indies, made the following interesting observations on the possibilities of fish-culture along with agricultural crops in British Guiana:

"In British Guiana, the intensely cultivated alluvial coast lands under sugar and rice are irrigated by a complicated system of canals and trenches; for every square mile of cane cultivation there exist 16 miles of irrigation canals 40 feet wide, 4 miles of drainage canals also 40 feet wide and 45 miles of 4 feet drains. Flood fallowing for periods of six months to a year is a standard practice, and this and the rice padi fields afford further considerable acreage under water and entire mechanical control. These canals are assiduously fished and when a flood-fallowed field is drained there is often a general scramble for the fish left stranded. My suggestion is that these areas under water could be made much more productive by stocking with fingerlings of indigenous fish reared in hatcheries in order to supplement the natural rate of reproduction, and to meet the heavy fishing load. This would be coupled with management of the fishing load by such measures as temporary closures and control of gear. There is a brief description of this canal system in the *Agricultural Journal of British Guiana*, Volume 9, No. 4, pp. 201-202, December 1938.

"Although the culture of fish on these lands should be profitable, I put forward these suggestions for stocking and fishery management not only from a revenue-producing standpoint but in the interests of public welfare, with the object of making available significant amounts of animal protein to labouring populations whose diets are generally deemed to be deficient in animal protein. At least 40 per cent. of this population are immigrants or their descendants from India."

It will thus be seen that under the stress of war and with a view to "Grow More Food", all suitable water areas are being stocked to make them much more productive. It is hoped that in India also this aspect of fish culture will receive due consideration at the hands of the agricultural and fisheries authorities.

SUNDER LAL HORA.

---

1. Nicholson, F. A., *Bull. Madras Fish. Deptt.*, 1907, **2**, 86, 87, 100, 101. 2. Mitter S. C., *A Recovery Plan for Bengal*, 1934. Calcutta, 243. 3. Nicholson F. A., *Bull. Madras Fish Deptt.*, 1917, **11**, 158. 4. Gupta, K. G., *Reports on the Results of Enquiry into the Fisheries of Bengal and into Fishery Matters in Europe and America*. 1908; Calcutta, 102. Director of Fisheries, Madras, "Pisciculture", *The Allahabad Farmer*, 1933, **7**, 1 3; Mitter, S. C., *A Recovery Plan for Bengal*, 1934, Calcutta. 243; Mázumdar, C. H., *Financial Times*, 1939, December, 4. 5. This would seem incredible, for in an average good tank Catla grows to a seer and a quarter and Rohu to somewhat less than a seer in the course of a year. However, extensive and careful enquiries made in the Abad show that the rate of growth reported by Babu Priyanath Sao is not improbable. I had a tank netted at Gurgaria where Pona fry had been liberated about four months earlier and found that Catla had within that short period attained a weight of 1¼ seer and Rohu about 7/8 seer. 6 Khan, Hamid, *Jour. Bom Nat. Hist. Soc.*, 1942, **53**, 416–27. Das, B., *Proc. Ind. Assoc. Cult. Sci.*, 1917, **3**, 6 21. Ghose, A., and Ghosh, N., *Bull. Dept. Fish. Bengal*, 1922, **18**, 3–8. 8. Mazumdar, C. H., *Science and Culture*, 1940, **5**, 735–38. 9. The raising of short term agricultural crops alternately with fish culture is considered very desirable by a number of authorities, such as Prashad, B., *Bull. Deptt. Fisheries, Bengal and Bihar and Orissa*, 1919, **13**, 4; Lal, Chaman, *The Modern Review*, December 1942, 472. 10. Panikkar, N. K. *Journ. Bom. Nat. Hist. Soc.*, 1937, **39**, 343–53.

THE ECONOMIC ASPECTS OF STATE GEOLOGICAL SURVEYS*

BY

CYRIL S. FOX

(Director, Geological Survey of India)

THE old fashion belief that a State Geological Survey was more ornamental and academic than practical and useful has, I think, nearly disappeared as a result of the work carried out by the Russian Geological Survey under the drive for industrialisation by the Soviet Government. In the Union of Socialistic Soviet Republics, scientific training and equipment has not been spared in the continent wide search, exploration and exploitation of ore deposits and mineral occurrences for materials for the metallurgical and other industries in Russia. However, elsewhere in Europe and in America there remains a considerable difference of opinion as to whether a Geological Survey should extend its operations into the sphere of experimental investigation to demonstrate, on a semi-commercial scale, processes for the treatment and the preparations of ores and minerals.

In the case of the Russian Geological Survey, the work covers the entire field from routine mapping, care of the museums and educational details for training personnel to prospecting and development operations, to advisory appointments, for problems of engineering geology, metallurgical matters, questions of oil research, geophysical investigations and experimental work. In the United Kingdom, the Geological Survey of Great Britain has less to do with practical mineral development, but specialises in field mapping, questions of water-supply and in exhibiting beautiful mineral and similar collections. Similarly, the Mines Department in Great Britain is almost entirely used for the administration of the Mining Rules for effecting safety in working the mines.

The Department of Mines in Canada contains two branches—(*a*) the Geological Survey branch based on the English pattern, and (*b*) the Bureau of Mines branch which is essentially an experimental research organisation. In the case of the United States of America where they have two separate organisations—(*a*) the Geological Survey and (*b*) the Bureau of Mines, both on an even far more elaborate plan than their equivalent organisations in Canada—(*a*) and (*b*) are controlled from two different Departments of the United States Government. The Geological Survey of the U.S.A. has a special Hydrographic Branch and also include the Topographic Survey in addition to its work on mineral surveys and museum collections.

The Geological Survey of India has its nearest counterpart in the Russian Geological Survey, which existed before the Soviet Government assumed control and expanded its activities to include all the work which is conducted by the Canadian Department of Mines, and much more besides. From its initiation in 1846, the Geological Survey of India has operated for the purpose of developing the mineral resources of this country, and has operated mines as well as conducted investigations on minerals, ores and related substances with a view to their utilisation. Previous to 1902, mining and metallurgical specialists were recruited for the Geological Survey of India to enable this Department to carry out its operations in field geology as well as in mineral developments.

In 1902, the mining and metallurgical specialists of the Geological Survey of India were utilised to be a nucleus to the newly formed Bureau of Mines Inspection, which is the Indian Mines Department and based on the English model chiefly as an Inspectorate. The Geological Survey of India was thus robbed of the mining engineers and metallurgists who provided the experts for actual mineral development after the exploratory surveys had located the minerals of economic value. Although the loss of this mining personnel was painfully evident when the Indian Munitions Board came into being in 1917, this defect in the cadre of the Department was not remedied, when a post-war re-organisation was carried out in 1922. Indeed the Geological Survey of India was almost brought into line with its opposite number in Great Britain.

The two steps, that of creating the Mines

* Substance of a lecture delivered before the "All Bengal Economic Conference" held in Calcutta on 12-4-43; specially contributed by the author to *Current Science*.

Department in 1902 on the English model, and that of not introducing a true Bureau of Mines on the Canadian pattern when the re-organisation was made in 1922, reduced the Geological Survey of India from an organisation for mineral development as its objective to a department whose chief objective was to complete the geological map of India. This was equivalent to having an architect to prepare drawings of a new building or a new city, without having the plans and estimate passed and engineers engaged for the actual constructional work. Some effort was, however, made to help in mineral development, but the Geological Survey was not staffed nor properly equipped for any serious work of this kind and when mineral development became a Provincial subject in 1937, no corresponding field parties were formed for special assistance to the local Governments.

With the threat of war in Europe quite evident in 1938, and the lack of a technological organisation on the lines of the Canadian Bureau of Mines keenly felt, an effort was made to at least restore the Geological Survey of India to the position it held previous to 1902. This was partly effected in 1939 and 1940, and improved somewhat in 1941, when the sulphur operations at Sanni and in Koh-i-Sultan were initiated and other explorations were undertaken in Madras and elsewhere. The establishment of an Utilisation Branch of the Geological Survey of India in 1942, however, completely restored the position of the Department, and permitted operations to be undertaken with specially recruited mining engineers and metallurgists. The chief exploration in progress is that of re-opening one abandoned lead-zinc ore mines at Zawar, Udaipur, Rajputana.

It is necessary to point out at this stage that no provision has yet been made for an experimental or demonstrational, technical organisation which might be the equivalent of the Bureau of Mines in Canada or that in the U.S.A. It is quite erroneous to consider the Utilisation Branch of the Geological Survey of India as in anyway the initiation of an organisation even resembling the Canadian Bureau of Mines. In its present form the Utilisation Branch is simply an expansion of our prospecting operations, so that we are proving the sulphur deposits in Baluchistan, exploring the lead-zinc ore lodes in Udaipur, operating some mica mines in Monghyr, encouraging the search for rare minerals and endeavouring to procure wolfram from discouragingly small occurrences. A start has also been made to examine certain old tin and copper mines.

Except for beginning a geophysical investigation of a manganese ore deposit and continuing this kind of exploration to the mica-bearing pegmatites, there has been no organised experimental research. Personal efforts have been made for refining the Baluchistan sulphur rock, but this is now regarded as outside the scope of the Utilization Branch. I have conducted a research on the electrical properties of the muscovite micas of Bihar and Madras, and continuing these investigations in examining the sparking plugs and electrical condensers, using mica, in our aircraft. In the past few months we have also experimented with the preparation of tungsten trioxide from wolfram, the conversion of non-caking into coking coals, the production of smoke haze screens, the use of various coloured earths and ochres for camouflage, etc. However, all these are individual rather than departmental researches.

I think it can be safely said that the activities of the Utilisation Branch are more closely connected with the normal operations of an energetic Geological Survey than those which might be expected from an established Bureau of Mines. It would, in my opinion, be a folly as great as that of 1902, if the working of the present Utilisation Branch was separated from the Geological Survey. There is no doubt that mining operations should be conducted by qualified mining engineers, just as drilling for oil should be carried out by the most skilled drillers. This does not separate oil-drilling from oil-geologists. I think every oil company of any importance recognises that their success depends on the guidance of their geologists. To believe anything different in the case of ore or mineral explorations is to court trouble to say nothing of unnecessary expense.

I am the first to admit quite frankly that there is an immediate need for an organisation like the Canadian Bureau of Mines in India, but it will be prudent to establish it as a new institution and later make adjustments between this Minerals Research Branch and the Utilisation Branch of the Geological Survey. I agree also that the Minerals Research Branch of the Bureau of

Mines can be quite separate from the Geological Survey, but this is not true of the Utilisation Branch as it is at present. It is actually a part of the Geological Survey and no adjustment can be made until a properly planned Bureau of Mines or Minerals Research Branch is operated. The geologist may take a back-seat when a mining engineer drives, but the driver will often require guidance and even instructions from the back-seat geologist. The responsibility always lies with the geologist, while praise usually goes to the engineer.

It is of interest to know that the number of geologists on the staff of the Burma Oil Company in Burma was about three times that of the Burma Geological Department. There were reported to be no less than 6,000 geologists in the employ of the Soviet Government in 1937, indeed the number was given to me as roughly 10,000 geologists. On a comparative estimate the Geological Survey of India should have about 600 geologists but even on the basis of one geological officer to every district in India, the number is roughly 300 as against about 60 at present employed, many of whom are on a temporary understanding. It is difficult to convince the Government of India that even 150 official geologists are actually necessary for a thorough search of India for minerals which are now regarded as of economic importance. If, however, sanction was accorded for this number of suitably qualified geologists, it would be practically impossible to procure them in India.

There is already difficulty in recruiting Indian geologists who have experience enough and the requisite qualifications to undertake responsible work. Indeed we have had to resort to the expedient of employing post-graduate scholars, fresh from various colleges, etc., as Geological Assistants on a nominal salary and give them field training and experience under special officers. The problem of future recruits is so serious that I recommend it should be taken up with the various centres where geology is taught in India in order that some arrangement is made with the advice of the Geological Survey of India for meeting the demand which already exists. As a further measure of prudence, I would advise the employment of at least 12 experienced European geologists, who are in India as evacuees, on the Geological Survey in order that young Indian geologists may work under their guidance. This is because we are so short handed.

In conclusion it may help to an understanding of the position if I show that since 1846 there have been about 120 geologists on the staff of the Geological Survey of India and that the average field service of these men has been about ten years, while the annual work done by each geologist in mapping is roughly 500 square miles. This means that an area of about 600,000 square miles should have been surveyed in fair detail in India and Burma in the past ninety-seven years, or about one-third the total area involved. Although there are extensive areas of alluvium, there are also areas in which the geology is very complex, so that an average of 500 square miles is not to be misunderstood. It is a question therefore whether it is not better to search the country quickly and thoroughly by employing a larger staff or simply going on in our present rather old fashion way.

CALCUTTA,
March 16, 1943.

SCIENTIFIC DISCOVERY

IF there is one fact which stands out more than any other in the history of science, it is the remarkable extent to which great discoveries and youthful genius stand associated together. Scores of instances can be quoted in support of this proposition. The fact of the matter appears to be that, other things being the same, the principal requisite for success in scientific research is not the maturity of knowledge associated with age and experience, but the freshness of outlook which is the natural attribute of youth. The conservatism which develops with increasing age is thus revealed as a factor which militates against great achievements in the field of science. The principal function of the older generation of scientific men is to discover talent and genius in the younger generation and to provide ample opportunities for its free expression and expansion.—From a broadcast by SIR C. V. RAMAN. (Courtesy of *Indian Listener*.)

THE ORIGIN OF THE "ROHR" OR ANHYDROUS SODIUM SULPHATE BEDS BELOW THE SALT PANS AT DIDWANA

BY

E. SPENCER, D.Sc. (LOND.), F.I.C.

(Technical Adviser, Messrs. Bird & Co., and F. W. Heilgers & Co., Calcutta)

IN the January issue of *Current Science*, Dr. Dunnicliff[1] describes these Didwana sulphate deposits and explains their origin by separation of the decahydrate from the pan brine during the early colder period of the salt season, and the subsequent transformation of this decahydrate to the anhydrous salt. During a recent visit to this area I had the opportunity of examining the sulphate beds and of seeing something of the conditions under which they must have been laid down. It appears to me that an alternative explanation of their origin can be put forward, more in harmony with the facts.

QUALITY AND QUANTITY

Before discussing the origin, I would like to stress the remarkable freedom from sodium chloride of these "Rohr" deposits, especially if one remembers that they have originated by crystallisation from a solution containing three times as much chloride as sulphate. Up to the present time 200-300 tons of this material have been consumed by the Titaghur Paper Mills and this has all been carefully sampled wagon by wagon and analysed. The following figures indicate the average quality of this 200 tons:

	1	2	3	4	5	6	7	8
Moisture	0·15	0·15	0·10	0·20	1·13	0·88	1·82	0·74
Insolubles	5·26	4·66	6·70	5·65	11·89	5·37	6·06	9·42
Sodium sulphate	92·2	92·44	89·9	91·9	85·3	92·65	90·17	86·93
Sodium chloride	0·23	0·46	0·53	0·80	0·45	0·53	0·26	1·17
Sodium carbonate	0·21	0·10	0·10	0·10	0·21	0·16	0·22	0·17
Sodium bicarbonate	0·34	0·59	0·42	0·42	0·42	0·42	0·34	0·42
Iron and Alumina (as sulphates)	0·56	0·28	1·12	0·56	ND	ND	ND	ND
Calcium sulphate	0·36	0·24	0·24	0·24	ND	ND	ND	ND
Magnesium sulphate	0·30	0·30	0·45	0·30	0·30	0·30	0·40	0·45
	99·59	99·22	99·55	100·17	99·7	100·31	99·47	99·35

It will be seen that the average sodium chloride content runs well below one per cent., even on a basis of "silt free" material. It may be that the "Rohr" excavated from subsequent pan beds will contain more chloride, but this does not seem likely, since the above analyses probably represent a fair average of the 5,000 tons of "Rohr" excavated so far from four pans opened up. I understand that there are in all about 250 salt pans, and if these produce the same relative amounts of "Rohr" as the four pans excavated, there should be something in the order of 250,000 tons available at Didwana.

At the time of my visit a bed of "Rohr" two to three feet thick was exposed in one of the partly excavated pans. This bed consisted of massive interlocking crystals of the anhydrous sulphate "Thenardite".

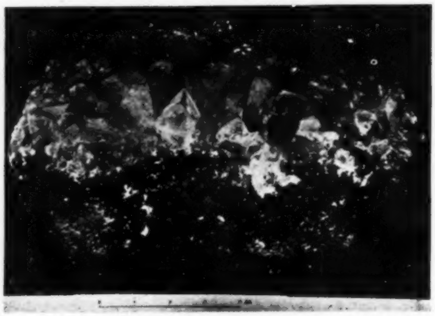


FIG. 1

Specimens were obtained showing clusters of undamaged glass-clear crystals with individuals up to two inches in length and breadth. These are shown in the attached photographs. The crystals belong to the Orthorhombic system and are pyramidal, the principal face being a pyramid probably the Unit Pyramid (1.1.1).

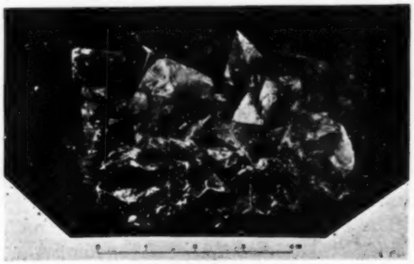


Fig. 2

ORIGIN OF THE DEPOSITS

According to Dr. Dunnicliff these "Rohr" deposits have been derived from crystallisations of the decahydrate (Na_2SO_4. 10 H_2O) during the early cold weather period, when the pans are first filled with the well brine. The assumption is that during this period the temperature falls below the transition point for Na_2SO_4-Na_2SO_4. 10 H_2O and that the decahydrate (Glauber's salt) then crystallises out. In order to understand this process and its implications, it is necessary to know something of the relative solubilities of sodium chloride and sodium sulphate and the effect of the chloride on the transition temperature of the sulphate.

Solubilities.—The solubility of sodium sulphate (in the absence of sodium chloride) is fairly high but varies rapidly with the temperature as is indicated by the figures given below:[2]

Temperature	Solubility
40°F.	5%
60°	15%
80°	35%
90°	48%
93·2°	55%
100°	50%

Sodium chloride progressively decreases the solubility of the sulphate as is shown by the following solubility figures for a temperature of 90° F.

Sodium Chloride	Sodium Sulphate
5·25%	26·0%
9·45%	20·3%
16·10%	13·3%
22·0 %	7·8%

At 90° F. a solution containing 22·0 per cent. sodium chloride and 7·8 per cent. of sodium sulphate is saturated with regard to both components and if allowed to evaporate at this temperature both salts crystallise out simultaneously, the composition of the "mother liquor" remaining constant. Solutions of the two salts on each side of this composition ratio will, on evaporation, deposit the one in excess until the above saturation ratio is reached.

Reducing the temperature of this "mother liquor" below 90° F. does not markedly reduce the solubility in respect to the sulphate (or chloride). Thus at 40° F. a solution saturated in respect to the chloride and sulphate still holds about 5 per cent. of the latter salt.[3]

Transition Temperatures.—At temperatures above 90° F. pure sodium sulphate solutions deposit the anhydrous salt (Thenardite) on evaporation. Below this temperature the decahydrate comes out. Sodium chloride depresses this transition temperature of the sulphate progressively, until in a solution saturated with respect to the chloride, the transition temperature has fallen to 64·2° F.

Practice at Didwana.—At Didwana the well brine is first fed into the pans about the middle of February. This brine contains on an average about 6 per cent. of sodium sulphate and about 18 per cent. of sodium chloride.[1,4] The maximum day temperature is then about 70° and the minimum night temperature 40° to 45° F. These are atmospheric temperatures and as indicated by Dr. Dunnicliff[1] it is probable that the ground and pan liquor temperatures may be as much as 15° F. higher than the minimum. On the coldest nights, however, the temperatures may fall occasionally below the transition point for the sulphate in which case some decahydrate would separate out. The amount could not be large, since the well brine only contains about 6 per cent. of sulphate and we have seen that 5 per cent remains in solution even at as low a temperature as 40° F.

Normal evaporation would, however, gradually increase the concentration of the sulphate (and chloride) until the saturation point had been reached. The brine would then contain about 22 per cent. of sodium chloride and about 8 per cent. of the sulphate. These conditions would be reached towards the end of February, by which

time the minimum night temperatures would have increased so as to reduce the possibility of decahydrate formation, especially in view of the temperature lag of the ground and the pan brine.

Let us assume, however, that the necessary low temperatures did obtain and that the maximum possible amount of decahydrate crystallised in this way from the saturated well brine prior to separation of the chloride. The amount so crystallised would be the difference between the solubilities at say 80°-90° F. and at 40° F., that is, 8 per cent. — 5 per cent. = 3 per cent. or only about 37 per cent. of the total sulphate in solution in the first batch of concentrated well brine fed to the pan to produce the first salt crop. From that time onwards the temperature would never again fall sufficiently low for the formation of the decahydrate in such a concentrated solution of the chloride.

During the season about five crops of salt are produced from successive additions of well brine. Hence the maximum amount of sulphate which could separate as decahydrate under the most favourable conditions would only be about 8 per cent. of the total sulphate content of the well brine fed to the pans during a season, which corresponds to about 2·5 per cent. by weight of the salt manufactured. The average annual production of salt over the past seventy years is about 13,000 tons and 2·5 per cent. of this is only 320 tons. At this rate of formation it would have taken about 800 years to accumulate these "Rohr" deposits.

A comparative study of the composition of the well brine and of the salt produced at Didwana also indicates that a much larger amount of sulphate has disappeared from the system than would be accounted for by an early separation as decahydrate. The analyses figures of Dr. Dunnicliff and others[1,4,6] show that the ratio of sulphate to chloride in the well brine is about one to three and only about one to eight or nine in the commercial salt (NaCl) produced. This represents a loss of more than 60 per cent. of the total sulphate fed into the pans, or about 8 times the amount which could have separated as decahydrate. Moreover, this sulphate must have crystallised *pari passu* with the salt throughout the season, otherwise the later salt crops would have been so enriched in sulphate that they would have been unsuitable for consumption. Unlike the practice at Sambhar Lake, there is no removal of concentrated "Bittern" liquor from the crystallising pans at Didwana. As a matter of fact there would be no point in doing this, since the ratio of sulphate to chloride in the original well brine is almost as high as it is in the rejected "Bitterns" of the Sambhar Lake area. When the Didwana brine reaches crystallisation point by evaporation, it is almost saturated in respect to sulphate as well as chloride and the two salts must come out together, the only further enrichment of the "mother liquor" being in regard to the small amounts of carbonate and bicarbonate present.

Crystallisation Tests.—In an endeavour to obtain a clue to the discrepancies indicated above, laboratory experiments were carried out with saturated solutions of Didwana salt and sulphate. These were allowed to crystallise by evaporation at a temperature of about 90° F. Crops of crystals were removed periodically and examined, the mother liquor being analysed after the removal of each crop. Samples of the mother liquor were also allowed to crystallise on slides under the microscope.

It was found that when the mother liquor had reached a concentration of 22 per cent. sodium chloride and 7·8 per cent. of sulphate the two salts crystallised out simultaneously during slow evaporation, the liquor remaining constant in composition. In the shallow crystallising dish used, the chloride tended to form spongy box-shaped crystals which floated on the surface and eventually collected together in the form of a scum or layer. On the other hand the sulphate invariably crystallised as small dense double ended pyramids which separated mainly on the bottom of the dish forming eventually, a crystal layer or crust. Where crystallisation was clogged and rapid (round the edges of the dish or between the floating sodium chloride crystals) contamination with sulphate crystals occurred, but with free crystallisation as in the body of the liquor, the two salts crystallised separately. This is to be expected from the different crystallisation systems to which the two salts belong, the chloride to the cubic and the sulphate to orthorhombic system.

In one experiment, after a "crop" of chloride crystals had accumulated on the surface and had been removed, leaving a thin compact layer of sulphate crystals (with some chloride) on the bottom—the mother liquor was made up to the original

volume with a solution of the same composition but diluted slightly with water. By the time the liquor had again reached saturation point the chloride had been dissolved out from the bottom layer in the dish, leaving a thin layer of pure sulphate, which increased in thickness during the formation of the next crop of chloride crystals.

When crystallisation of the *saturated* mother liquor was observed on a slide under the microscope, it was noted that sodium chloride was *invariably* the first to crystallise, leaving a small quantity of liquor temporarily supersaturated in respect to the sulphate. The sulphate eventually crystallised as separate individuals, along with the last chloride crystals.

Interpretation of Results.—Assuming that crystallisation has taken place in the salt pans on the lines indicated above, the tendency would be for the smaller and more compact sulphate crystals to find their way to the bottom of the pan below the larger spongy salt crystals. This tendecy would be accentuated by the greater density of the sulphate than the chloride crystals (2·7 against 2·2) and by the density of the solution (1·25). It would also be greatly assisted by the raking and ridging process to which the salt crystals are subjected, in the pans. This process is carried out in order to encourage the formation of larger salt crystals (NaCl) and to prevent the tendency of the salt to form an adherent cake. There is no doubt, that with this difference in density of sulphate and chloride crystals, suspended in such a dense solution, the raking would tend to cause a gravity separation, somewhat similar to the jigging process commonly used in mining to separate minerals of different specific gravity.

After removal of each crop of salt crystals from the pan, more well brine is added and for a short period the pan liquor must be unsaturated with respect to chloride and sulphate. In becoming saturated the well brine is able to dissolve three times as much chloride as sulphate, so that the tendency would be to dissolve up any sodium chloride remaining in the pan from the residue of the salt crop, leaving the sulphate crystals in the bottom of the pan in a relatively pure condition.

This explanation would account for the difference between the sulphate contents of brine fed into the pans and that in the salt crop produced, a difference in the order of 20 per cent. of the total weight of salt manufactured. Taking the average yearly production at 13,000 tons, 20 per cent. would represent an annual accumulation of 2,600 tons of sulphate, or 250,000 tons in about 100 years. This seems a more reasonable figure than 800 years.

It is worthy of note that without analytical help or guidance, the ancestors of these Didwana salt workers, or "Deswals" have evolved a simple and economical method of extracting a marketable salt (NaCl) from a brine so rich in sulphate. At the same time they have, unwittingly stored up, over several decades, rich deposits of nearly pure anhydrous sulphate, a salt for which there is now an ever-increasing demand.

Sambhar Lake.—Combined to the Didwana well brine, the brine of Sambhar Lake is relatively very much richer in chloride than sulphate (and carbonate) as the following figures show.[7]

Sodium chloride—23·1 per cent.
Sodium sulphate—2·1 per cent.
Sodium carbonate—0·45 per cent.

The practice at Sambhar is to separate as much as possible of the chloride by evaporation, until the "mother liquor" approaches saturation point in respect to the other constituents, and then to discard it as "bitterns". In this way about 75 per cent. of the salt content of the brine is removed.

Average analyses[5,7] of this "bittern" liquor show that it contains approximately:

Sodium chloride—20·0 per cent.
Sodium sulphate—8 per cent.
Sodium carbonate—4 per cent.
Sodium bicarbonate—1 per cent.

If we disregard the carbonates this composition is not very different from that of the concentrated Didwana brine, and the question naturally arises whether the Didwana method of separation might not be applied to these bitterns to produce a saleable chloride, leaving the bulk of the sulphate (or sulphate-carbonate) behind at the bottom of the pans.

Summary and Conclusions

It is not disputed that Glauber's salt can be separated from Didwana well brine on the lines indicated by Dr. Dunnicliff and Saha, or that given suitable machinery for cooling and evaporation, practically the whole of the sulphate could be recovered as decahydrate from the brine, leaving the chloride in a fairly pure condition. Separation as decahydrate, however, does not

adequately explain the origin of these "Rohr" deposits, since the formation of the hydrous sulphate is only possible during the very early days of the crystallising season. The alternative explanation here put forward is that the anhydrous sulphate has crystallised, along with the chloride, throughout the salt season and that its partial separation from the latter in the form of "Rohr" at the bottom of the pan has been brought about by several factors operating together. These include:

(*a*) The tendency of the sulphate to form relatively small dense crystals and for these to find their way to the bottom of the pan by the mechanical action of stirring or "ridging".

(*b*) The tendency of the solution to become supersaturated in respect to sulphate and for this excess sulphate to crystallise at the bottom of the pan through density diffusion and where the temperature may be lower.

(*c*) The tendency of the chloride to crystallise as spongy "boxes" which float on the surface and eventually form a crust or layer.

(*d*) The removal of the salt crop and the replenishment of the pan with unsaturated well brine which dissolves out the chloride from the bottom sulphate layer, and allows the above process to be repeated again and again.

If this view is correct, a careful study of the practice at Didwana might yield information which would be of value in enabling the controlling factors to be so adjusted as to yield a still better separation of chloride and sulphate.

---

1. Dunnicliff, H. B., *Curr. Sci.*, 1943, **12,** 7-12. 2. Martin, G., *Industrial and Manufacturing Chemistry*, 1917, **1,** 2. 285. 3. Robertson, J. R., *Journ. Ind. Eng. Chem.*, 1942, **34,** 133-136. 4. Auden, J. B., *Rec. Geo.. Surv. Ind.* Prof. Paper No. 1, 1942, **67,** 36. 5. *Loc. cit*, p. 33. 6. *Appendix Report—Salt Survey Committee*, Gov. Ind. Press, Calcutta, 1931, p. 100. 7. Hacket, C. A., Salt in Rajputana," *Rec. Geol. Surv. Ind.*, 1880, **13,** 3, 200.

NEPHRIDIA OF EARTHWORMS

IN a series of four memoirs recently published in the *Quarterly Journal of Microscopical Science* (Vols. 83 and 84), Prof. K. N. Bahl of the University of Lucknow, whose previous work on the nephridia of earthworms is so well known, has further added to our knowledge of this subject. In the first memoir he gives an account of the nephridia of the genus *Eutyphœus,* in which three kinds of minute nephridia—septal, integumentary and pharyngeal—can be distinguished. Of these the first two kinds open to the exterior, while the tufts of pharyngeal nephridia open into the lumen of the pharynx. He next describes the interesting nephridia of the genus *Hoplochœtella* which possesses large septal nephridia resembling those of *Lumbricus,* besides minute integumentary and tufted pharyngeal nephridia. The septal nephridia are remarkable in that they do not open separately to the exterior, but into a pair of longitudinal canals running along the parietes through the greater part of the body of the worm; these canals discharge their contents into the gut at its posterior end. The second memoir deals with three examples of multiple funnels. The South American giant earthworm *Thamnodrilus crassus* possesses nephridia, each of which possesses as many as *thirty four* functional funnels; the nephridium of *Hoplochœtella* has one large functional and 18 to 24 vestigial funnels; while the funnel of the nephridium of *Lampito* has two or three masses of cells, looking like embryonic funnels, on the neck of the single functional funnel. In the third memoir the nephridia of the different regions of the body of *Pontoscolex corethrurus* are described. This worm exhibits a very interesting condition of branching and division of the nephridia—in fact, the holonephridia are here "caught in the act of dividing up" into meronephridia, but the division is never complete, as even when hundreds of meronephridia are formed, as in the anteriormost pair of nephridia, they open to the exterior by a single bladder-like duct. In the fourth memoir the author describes the occurrence of the "enteronephric" type of nephridial system in *Megascolex cochinensis,* a type already discovered by him in four other genera of earthworms. The four memoirs form a very important contribution to our knowledge of the excretory system of the Oligochæta. B. P.

SIR CYRIL S. FOX, Kt., D.Sc., F.G.S., M.I.Min.E., F.R.A.S.B., F.N.I.

IT is with real pleasure that we offer our felicitations to Dr. Cyril S. Fox, Director, Geological Survey of India, on the 'Knighthood' that has been recently conferred upon him by His Majesty the King-Emperor. As an officer of the Geological Survey for more than quarter of a century, Sir Cyril Fox has made many outstanding contributions towards a fuller knowledge of the geology and mineral resources of India. There is practically no part of the country with which he is not personally familiar; nor is there any major problem in Indian geology towards the discussion of which he has not made valuable and illuminating contributions. In addition to his numerous and varied activities on the purely geological side, Sir C. S. Fox has always evinced considerable interest in the applied aspects of geology—especially in connection with Mining and Engineering; and his work in this field has secured widespread appreciation and recognition. As Director of the Geological Survey of India he has, within the last few years, reorganised the entire work of the Department, and given it a new orientation altogether, with a view to serve better the needs of the country; and this, together with the recent formation of the Utilisation Branch of the Survey, in the planning and organisation of which he has taken a leading part, will no doubt usher in a new era in the development of the mineral resources of the country, so essential for the future national progress of India.

Sir Cyril Fox has been a sincere friend and well-wisher of *Current Science* ever since its inception, and has contributed not a little towards the growth of the Journal all these years. We are particularly happy to see that his work has been so fittingly recognised by the conferring of this signal honour and we wish to take this opportunity of offering him once again our hearty congratulations, and best wishes for many more years of active and useful service in the cause of India.

DR. C. G. PANDIT, M.B.B.S., Ph.D., D.P.H., D.T.M., F.N.I., O.B.E.

"*CURRENT SCIENCE*" notes with satisfaction that the work done by Scientific Research Institutions is being increasingly recognised by the Government. We record with pleasure the conferment of O.B.E. on Dr. C. G. Pandit. This is as it should be.

Dr. C. G. Pandit is the first permanent Indian Director of the King Institute of Preventive Medicine, Guindy, one of the few recognised leading Indian Medical Research Institutions in this country. After a brilliant academic career, Dr. Pandit proceeded to England for further studies and secured the PH.D. degree of the London University for research in Bacteriology. He entered service in the Indian Research Fund Association and was posted to Madras. He was the first Professor of Bacteriology in the Madras Medical College where he was extremely popular with students. He held the much coveted Rockfeller fellowship which brought him into touch with the leading American bacteriologists. In 1934 he was selected as the Indian delegate of the Government of India to attend the session of the Congress of the Far Eastern Association of Tropical Medicine held at Nanking, China. In 1939 he received the Minto Gold Medal "for distinguished work in tropical medicine by an Indian", for the year. At the outbreak of the present world war he was specially deputed to America by the Government of India to study the problem of yellow fever, as a possible menace on account of the speeding of air transport. In 1942 he delivered the presidential address of the Medical Section of the Indian Science Congress, making his mark as the foremost worker in the profession for the year. He is aged 48 years.

Dr. Pandit has initiated and carried out outstanding researches on Vaccine, Virus, Tissue-Culture, Filariasis, and Fluorosis. A man of singular charm, affable, persuasive and polished in manners, a fluent, impressive and informed speaker, he combines in him the best of the culture of the East and the West. His many friends in India and elsewhere would rejoice at this well-deserved recognition by Government. *Current Science* offers its felicitations to Dr. Pandit and has no doubt that the Institute which he directs would take greater strides under

his able guidance and lead him to still greater distinctions.

DR. J. J. RUDRA, M.A., Ph.D., M.B.E.

WE offer our warmest felicitations to Dr. J. J. Rudra on the conferment of M.B.E. in the recent Birthday Honours. After a brilliant post-graduate career first in the Indian Institute of Science, Bangalore, and later in the College of Technology, Manchester, where his work under Prof. Mileswalker brought him the PH.D. Degree, Dr. Rudra started his career as Lecturer in Electrical Technology, Indian Institute of Science, in 1931. The investigations of Dr. Rudra on different types of alternating current motors have made him an authority on this branch of Electrical Engineering. In 1935 Dr. Rudra went over to Madras to occupy the chair of Electrical Engineering at the College of Engineering, Guindy, and now he is Principal of the above College.

Dr. Rudra has always taken a keen interest in *Current Science*. Our cordial greetings to him and best wishes for a happy and successful career.

DIWAN BAHADUR DR. K. R. RAMANATHAN, M.A., D.Sc.

READERS of *Current Science* will receive with great satisfaction the happy news that Dr. K. R. Ramanathan, Superintending Meteorologist in charge of the Poona Observatory, has been honoured by the distinction of Diwan Bahadur in the latest King's Birthday Honours List. He started his career as Demonstrator in Science College, Trivandrum, and was placed in charge of the local Observatory. In 1921 he joined the Indian Association for the Cultivation of Science to work under Professor C. V. Raman. In 1922 he was appointed Lecturer in Physics in the Rangoon University, where he remained till 1925. Both during his stay at Calcutta and at Rangoon he published series of important memoirs on the molecular scattering of light, both independently and in association with Prof. Raman. He was awarded the D.Sc. Degree of the Madras University in 1923. In 1925 he entered the Indian Meteorological Service. In his long association with this Department for the past twenty years during which he has served at various centres, he has published several papers, especially on the physics of the upper atmosphere and allied topics. Dr. Ramanathan was selected for one of the three recently created posts as Superintending Meteorologist. He has contributed considerably to the organisation and progress of Meteorological Research in India. With the outbreak of war a heavy responsibility fell on the Meteorological Department of supplying trained technical personnel required for the rapidly expanding Indian Air Force. Dr. Ramanathan has been able to attract to the Department some of the best physicists from the various centres of research in India. Dr. Ramanathan has been a well-wisher for and has enthusiastically co-operated with this Journal from its inception. We offer him our sincere felicitations on the distinction.

DISCOVERIES BY ACCIDENT

IT is instructive, said Sir Oliver Lodge, to realise the state of mind which misses a discovery as well as, what is more commonly attended to, the more admirable state of mind which succeeds. Many experimenters had opportunities as good as Röntgen's to observe the X-rays which were generated in their laboratories. Sir Oliver Lodge cited the case of Rev. Frederick Smith who, on finding that the plates wrapped in a box near a tube were fogged was—so to speak—annoyed at this disturbance of his experiments, and kept the plates out of the way.

J. C. CHASTON (*Nature*, Jan. 9, 1943).

LETTERS TO THE EDITOR

	PAGE
The External Field of a Radiating Star in General Relativity. By P. C. Vaidya	183
Permeability and Hydrolysis of Sodium Soils. By M. R. Nayar and K. P. Shukla	183
The Nature of the Tea Oxidase System. By H. B. Sreerangachar	185
Catalysis of Dichromate-Hydrobromic Acid Reaction by the Oxalate Ion. By C. R. Viswanatham and G. Gopala Rao ..	186
Description of an Egg-Laying Female of the Indian Glow-worm, Lamprophorus tenebrosus *Walker.* By J. Samuel Raj	186
Fluctuation in the Weight of a Plant. By C. V. Krishna Iyengar ..	188
The Blood Groups of the Doms. By S. S. Sarkar	189
—By D. N. Majumdar	189

THE EXTERNAL FIELD OF A RADIATING STAR IN GENERAL RELATIVITY

It is well known that the generalization of Schwarzschild's solution corresponding to the external field of a radiating star has not yet been obtained. The internal field describes a mixture of matter and radiation. In the outer field there is the expanding inner zone of pure radiation, with radius r_1 at time t_1 beyond which the empty space is described by Schwarzschild's static solution. The zone of pure radiation is given by

$$ds^2 = -\left(1-\frac{2m}{r}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2) + \frac{\dot{m}^2}{f^2}\left(1-\frac{2m}{r}\right) dt^2, \qquad (1)$$

$$f(m) = m'\left(1-\frac{2m}{r}\right). \qquad (2)$$

[As usual an overhead dot denotes a differentiation with regard to t and an overhead dash a differentiation with regard to r. $f(m)$ is an arbitrary function of m.]

Since the lines of flow of radiation must be null geordesics the radiation tensor has to be

$$T^{\mu\nu} = \rho v^{\mu} v^{\nu} \qquad (3)$$

with

$$g_{\mu\nu} v^{\mu} v^{\nu} = 0 \qquad (4)$$

so that

$$(\rho v^{\mu})_{\mu} = 0 \text{ and } (v^{\mu})_{\nu} v^{\nu} = 0. \qquad (5)$$

The surviving components of the tensor are given by

$$-T_1^1 = T_4^4 = \frac{m'}{4\pi r^2}, \; T_1^4 = \frac{m'^2}{4\pi \dot{m} r^2}, \; T_4^1 = -\frac{\dot{m}}{4\pi r^2} \qquad (6)$$

For differentiation along a line of flow we have the operator

$$\frac{d}{d\tau} \equiv e^{-\lambda/2}\frac{\partial}{\partial r} + e^{-\nu/2}\frac{\partial}{\partial t}. \qquad (7)$$

It is found that the field equations amount to

$$\text{(i)} \; \frac{dm}{d\tau} = 0, \; \text{(ii)} \; \frac{d}{d\tau}(r^2 e^{-\lambda} T_1^1) = 0,$$

$$\text{(iii)} \; \frac{d}{d\tau}(r^2 \rho) = 0, \; \text{(iv)} \; \frac{dv^1}{d\tau} = 0. \qquad (8)$$

The equation that is most difficult to handle corresponds to $T_2^2 = 0$. But it can be shown to be equivalent to (ii). The equation of continuity then leads to (iii) and (iv) readily. Thus, along the lines of flow of radiation m, v^1 and $r^2\rho$ are all conserved. It is worthy of notice that m' is positive while $\dot{m}$ is negative. This as well as the results (6) and (8) are suggested by the Newtonian analogue.

The total energy of matter and radiation is conserved. m is the affective mass of the whole system at a point. The value of m at the boundary $r = r_1$ at $t = t_1$ is a constant, M. At time t_1, for all values of r exceeding r_1, the field is given by Schwarzschild's line-element corresponding to the value M. Also $\dot{m} = -f(M)$ when $r = r_1$ and $t = t_1$.

The new results are (1), (2), (6), (8). Further details and astronomical applications are considered in a paper to be published elsewhere.

My thanks are due to Prof. V. V. Narlikar under whose guidance this work was done and who showed me the result 8 (i).

Benares Hindu University,
March 22, 1943. P. C. Vaidya.

Einstein, Infeld and Hoffmann, *Annals of Mathematics*, 1938, p. 65; Narlikar, V. V., *Bombay Univ. J.*, 1939, **8**, 37.

PERMEABILITY AND HYDROLYSIS OF SODIUM SOILS*

For many purposes a correct idea of the effectiveness of leaching an alkali soil is necessary. For instance, in reclamation work leaching is often practised though we do not know how long it will take to remove the evil influences

* This work was carried out under the auspices of the Irrigation Research Section, P.W.D., U.P. Government.

of exchangeable sodium. The futility of this process has been emphasised by various workers,[1] but few have attempted to study it mathematically. The following short note is meant to indicate the changes in permeability and its relation to the content of exchangeable sodium due to leaching a soil with water.

A sodium soil in contact with water undergoes hydrolysis, sodium hydroxide and hydrogen soil being produced.

$$\mathrm{Z]\cdot Na + HOH \rightleftharpoons Z]\cdot H + NaOH} \qquad (1)$$

Under leaching conditions, the exchangeable sodium is gradually replaced from the soil complex and its place is taken more and more by exchangeable hydrogen, with a consequent increase in the permeability of the soil.

In order to see how the rate of percolation of water changes with gradual replacement of exchangeable sodium by hydrogen, pure sodium soil was prepared by leaching it first with 0·05N HCl and then with normal solution of sodium chloride. The excess reagents were removed by washing with water followed by washing with alcohol. The resulting sodium saturated soil was then treated with different amounts of dilute hydrochloric acid so as to introduce different quantities of exchangeable hydrogen in the exchange complex. The excess reagents again were removed by washing with water and finally with alcohol. These soils were analysed for the Na-content and then subjected to permeability tests. Three different soils were studied.

It is found that the permeability of hydrogen-sodium soils increases in a regular manner with the ratio of exchangeable hydrogen to base exchange capacity. If y is the rate of percolation of water in cms. per hour, H the quantity of exchangeable hydrogen in milliequivalents per 100 gms. of soil, and 'B' the base exchange capacity in m.e., then the following relation is found to hold good.

$$y = \mathrm{K}e^{n\,(\mathrm{H})/\mathrm{B}} \qquad (2)$$

K and n are constants. Table I refers to the results obtained in the case of one soil.

TABLE I

	H/B	y (observed) cms./hr.	y (calcuated) cms./hr.
1	0·90	·064	·064
2	0·81	·060	·059
3	0·75	·055	·056
4	0·60	·050	·050
5	0·48	·045	·045
6	0·25	·038	·037
7	0·09	·036	·036
8	0·04	·032	·031
9	0·00	·032	·030

The observed rates of percolation agree with the calculated ones. In the case of fully saturated sodium soils the calculated rates are a little low. This is probably due to hydrolysis which a pure sodium soil undergoes, readily in contact with water. The end value of y which is also the value for the constant K of equation (2) is obtained by extrapolation with the help of the equation. The values of the constants K and n together with other constants for three soils are given in Table II.

TABLE II

Soil No.	Clay content	B	K	n
13	21·85	10·0	·0300	0·84
12	27·44	14·8	·0095	1·22
5	27·60	20·5	·0024	2·60

The time required for a definite amount of exchangeable sodium to be released from the soil can be computed as follows.

The rate of loss of sodium from the exchange complex should depend on the quantity of exchangeable sodium and on the quantity of water, which in leaching conditions means the rate at which water percolates through the soil. The following differential equation is, therefore, necessary.

$$\frac{d\,(\mathrm{Na})}{dt} = -\,\mathrm{K}_1\,(\mathrm{Na})\,y \qquad (3)$$

In order to determine the integration constant K_1 sets of percolation tubes were fitted in which pure sodium soil was kept in contact with water for months together. The rate of percolation and the content of exchangeable sodium were found out from time to time. The difference in the sodium content per hour approximates to the expression $\frac{d\,(\mathrm{Na})}{dt}$. Knowing the sodium content and corresponding rates of percolation, constant K_1 can be evaluated. Table III gives the value of the constants in the case of two soils.

TABLE III

Soil 13

Na (m.e./100 gms.)	Leaching period in hours	$\frac{d\,(\mathrm{Na})}{dt}$	y	K_1
10·00	0	—	·032	—
9·93	744	$9\cdot4\times10^{-5}$	·032	$2\cdot9\times10^{-4}$
9·80	1392	$9\cdot3\times10^{-5}$	·032	$2\cdot9\times10^{-4}$
9·70	1080	$9\cdot2\times10^{-5}$	·033	$3\cdot0\times10^{-4}$

Soil 12

Na (m.e./100 gms.)	Leaching period in hours	$\frac{d\,(\mathrm{Na})}{dt}$	y	K_1
14·80	0	—	·009	—
14·74	1560	$3\cdot84\times10^{-5}$	·009	$2\cdot9\times10^{-4}$
14·69	1344	$3\cdot72\times10^{-5}$	·011	$2\cdot8\times10^{-4}$
14·62	1464	$4\cdot78\times10^{-5}$	·011	$3\cdot0\times10^{-4}$
14·55	1488	$4\cdot70\times10^{-5}$	·011	$2\cdot9\times10^{-4}$

The values of K_1 are practically the same in the two cases.

Substituting the value of y from (2), Equation (3) can be rewritten as:

$$\frac{d\,(\mathrm{Na})}{dt} = -\mathrm{K}_1\,(\mathrm{Na})\ \mathrm{K}e^{n\,(\mathrm{H})/\mathrm{B}} \qquad (4)$$

Since $(\mathrm{H}) = \mathrm{B} - (\mathrm{Na})$,

$$\frac{d\,(\mathrm{Na})}{dt} = -\mathrm{K}_1\,(\mathrm{Na})\ \mathrm{K}e^{n}\,e^{-n(\mathrm{NA})/\mathrm{B}} \qquad (5)$$

or

$$\frac{d\,(\mathrm{Na})}{dt} = \mathrm{K}_2\,(\mathrm{Na})\ e^{-n(\mathrm{NA})/\mathrm{B}} \qquad (6)$$

The equation (6) can now be integrated (equation 7) and the approximate time for a definite stage of hydrolysis can be calculated.

$$\mathrm{K}_2 t = \left[\log(\mathrm{Na}) + \frac{n(\mathrm{Na})}{\mathrm{B}} + \frac{n^2(\mathrm{Na})^2}{\mathrm{B}^2 2!} + \frac{n^3(\mathrm{Na})^3}{\mathrm{B}^3 3!} + \cdots\right]_{\mathrm{Na}_{(t)}}^{\mathrm{Na}_{(0)}} \qquad (7)$$

$\mathrm{Na}_{(0)}$ and $\mathrm{Na}_{(t)}$ represent sodium contents at the beginning and at the end of time t.

The series on the right is convergent. Making use of the first five terms only and substituting for different constants for two soils we get the following values:

	Time for 50% hydrolysis	Time for total hydrolysis
Soil 13	4·23 years	11·63 years
Soil 12	12·40 years	49·62 years

It should be noted that the rate of hydrolysis increases with the rate at which products of reaction are removed. In other words hydrolysis will be faster the greater the rate of percolation. It has also been observed that the rate of percolation is inversely proportional to the clay content and the base exchange capacity.[2] Hence the hydrolysis will be more pronounced in soils which are poor in clay content and of low exchange capacity.

Under field conditions a number of exchange reactions may take part along with those contemplated above. For instance, many alkali soils have a reserve of $\mathrm{CaCO_3}$ and the process of 'hydrolysis' is usually combined with the process of 'calcification'. The natural conditions in the field present a variety of such combinations. Further the greater compactness of the soil in the fields will tend to make the process of hydrolysis much slower than under laboratory conditions.

Chemistry Department,
Lucknow University,
April 6, 1943.

M. R. NAYAR.
K. P. SHUKLA.

1. Leather, Report of Usar Land Reclamation in U.P., 1914. 2. Nayar and Shukla, *Proc. Indian Sc. Congress*, **42**, p. 74.

THE NATURE OF THE TEA OXIDASE SYSTEM

THE cytochrome theory of tea fermentation advanced by Roberts[1,2] has not been substantiated so far by any direct evidence for the presence of cytochrome and cytochrome oxidase in tea leaf. A closer investigation of this aspect of the problem based on spectroscopic and manometric determinations has recently given results quite contrary to those of Roberts.

Cytochrome.—Spectroscopically cytochrome is easily detected in the reduced state by its characteristic absorption spectrum. In tea, by observing the cytochrome 'b' band, Roberts claims to have demonstrated the presence of cytochrome, not in the leaf, but in the basal portions of the stem. In choosing this tissue for observation his object was probably to exclude any interference from chlorophyll. In my examination of this tissue in finely ground suspensions and with added succinate or $\mathrm{Na_2S_2O_4}$ I could obtain no indication whatever for the presence of cytochrome. Similarly when other tissues of the tea plant were separately collected and tested none of them displayed any specific cytochrome bands.

Extraction of chlorophyll and tannin from leaf by acetone would eliminate their interference with the detection of cytochrome. Thus Yakushiji[3] has reported the presence of α-bands of cytochromes b and c in acetone-extracted spinach leaves. No cytochrome could, however, be detected in the acetone-extracted tea leaves and attempts to prepare cytochrome C from such material by the method of Keilin and Hartree[4] yielded only negative results.

There was again no spectroscopic evidence for the presence of cytochrome in highly active and concentrated solutions of tea enzyme in which cytochrome must be expected if the observed activity were due to the cytochrome system. Selective absorption was absent both in the ultraviolet and the visible regions of the spectrum.

Cytochrome Oxidase.—Preparations of cytochrome oxidase from goat heart muscle readily oxidised cytochrome C, such oxidation being denoted by the disappearance of the reduced cytochrome C spectrum. But a tea oxidase preparation which was highly active on catechol ($-\mathrm{Qo_2} = 170$) failed to oxidise cytochrome, reduced by Pd and $\mathrm{H_2}$, and its spectral characteristics persisted for a considerable period in presence of the enzyme. In the preparation of this enzyme our earlier method was further refined so as to minimise the inactivating effect of acetone on cytochrome oxidase, the acetone extraction being carried out rapidly at $-20°$ C. The leaf powder was then extracted with buffer at pH 7·0 and purified by fractional saturation with $\mathrm{(NH_4)_2SO_4}$ and dialysis. A suspension of the insoluble leaf residue gave results similar to those of soluble enzyme and it is clear that cytochrome oxidase is completely absent in both.

Corroborative evidence against the cytochrome theory was further obtained by $\mathrm{O_2}$ uptake measurements as given below.

Oxygen Uptake of Various Reaction Systems

Reaction	µl. O_2/hr.
1. Catechol + Tea oxidase	198
2. Reduced cytochrome C + Tea oxidase	0
3. ,, ,, + Succinate + Tea oxidase	3
4. ,, ,, + Succinate + Heart muscle oxidase	46
5. ,, ,, + Succinate + A succinic dehydrogenase preparation	9
6. Reaction 5 + Tea oxidase	11

The succinic dehydrogenase preparation used in the last two reactions had comparatively only a slight cytochrome oxidase activity. If tea enzyme had consisted of cytochrome oxidase it should have induced a greater O_2 uptake in reactions 2, 3 and 6 due to an increase in cytochrome oxidase concentration.

These results demonstrate unequivocally that tea oxidase cannot be identified with cytochrome oxidase. It appears, therefore, that without any positive evidence for the presence in the leaf of the components of the system Robert's cytochrome theory of tea fermentation cannot be considered as valid. On the other hand our previous finding[5] that tea oxidase is a polyphenol oxidase with an established specificity for O-dihydric phenols provides a simpler and a more satisfactory explanation of the tea fermentation process.

Details will be published elsewhere.

My grateful thanks are due to Sir J. C. Ghosh, Director, Indian Institute of Science, Bangalore, for the hospitality of the Institute laboratories and to Mr. M. Sreenivasaya for much advice and help in the course of this investigation.

Section of Fermentation Technology,
General Chemistry Dept.,
Indian Institute of Science,
and H. B. SREERANGACHAR.
Tea Research Institute of Ceylon,
Talawakelle, Ceylon,
May 5, 1943.

1. Roberts, E. A. H., *Biochem. J.*, 1940, **34**, 500. 2. —, *Ibid.*, 1941, **35**, 1209. 3. Yakushiji, E., *Acta phytochimica*, 1935, **8**, 325. 4. Keilin, D., and Hatree, E. F., *Proc. Roy. Soc.*, 1937, **B 122**, 298. 5. Lamb, J. and Sreerangachar, H. B., *Biochem. J.*, 1940, **34**, 1472.

CATALYSIS OF DICHROMATE-HYDROBROMIC ACID REACTION BY THE OXALATE ION

IN a previous publication[1] we have reported the marked catalytic effect that oxalate ion exerts on the reaction between dichromate and hydriodic acid. We have now found that the oxalate ion also catalyses the reaction between dichromate and hydrobromic acid. Under the conditions of our experiments and at the hydrogen-ion concentration employed, the velocity of the reaction between dichromate and hydrobromic acid is extremely slow, but in the presence of a small concentration of oxalate the speed of reaction becomes appreciable.

The reaction was followed by the estimation of the bromine liberated iodimetrically, after extraction with carbon tetrachloride. The concentration of oxalate used was between ·025N to ·075N; in this range of concentration the rate of reaction was from 20 to 45 times more than the rate of reaction in the absence of the oxalate ion.

The catalytic effect of the oxalate ion is so pronounced that we can set up a lecture demonstration experiment using this reaction.

The quantitative aspect of the reaction is under investigation.

Andhra University and
Andhra Christian College,
Guntur, C. R. VISWANATHAM.
April 30, 1943. G. GOPALA RAO.

1. Viswanatham, C. R., and Gopala Rao, G., *Curr. Sci.*, 1942, **11**, 102.

DESCRIPTION OF AN EGG-LAYING FEMALE OF THE INDIAN GLOW-WORM, *LAMPROPHORUS TENEBROSUS* WALKER

PAIVA, C. A. (1919) has given for the first time a very short description of the adult female Indian Glow-worm. Hutson, J. C., and Austin, G. D. (1924) in their bulletin on the Indian Glow-worm deal mostly with the breeding habits of the female. A detailed study of the structure of the adult female has not been made till now.

The females appear to be very rare and seasonal in occurrence. Till now only six specimens have been collected by me from inside Tambaram bushes at night just after heavy rains and one was actually reared out of a larva inside the laboratory. They vary from 55 mm. to 70 mm. in length and most of them have been observed to become dark and assume piceous margins round the terga soon after death.

The following description of the structure of the egg-laying female *Lamprophorus tenebrosus* Wlk. is based on a single specimen collected on 2nd December 1942, from the College premises, Tambaram, Chingleput District. My thanks are due to Prof. C. Lakshminarayanan, under whose supervision and guidance this study was made.

Length—70 mm.; Breadth—17 mm.

The whole body is pale ochreous with the lateral tergal areas clear and more or less diaphanous. The inner luminous mass of ovary is clearly visible at night through the thin dorsal plates. The head is highly retractile into the thorax and the extensive cervical integument presents during retraction a double folding which is rarely straightened out completely. The adipose tissue is concentrated at special regions of the body. Dorsally it occurs as milky white patches on either side of the terga, but somewhat diffused ventrally. It is also discernible through the translucent pleurites. The female exoskeleton is delicate and least chitinised. Certain articular sclerites in the basal region of the thoracic legs which are strongly chitinised and differentiated in the larva are ill-defined and imperfectly chitinised in the female. The adult female is apterous and larviform and appears to be degenerate. Although the plates are thin and clear with least pigmentation and the body plumpy and delicate, the tarsi and antennæ present adult coleopteran structure. The abdomen has become loose and plumpy to accommodate the large mass of ovary inside. The female moves about actively at night producing a most brilliant greenish white light outrivalling the larva or her own mate. At night she is frequently noticed to assume a peculiar pose with her abdomen curled up and the photogenic organs exhibited to the best advantage to the flying males.

Head (length—6 mm.; breadth—5 mm.).—Head is prognathous, dorso-ventrally flattened, glabrous and slightly darker than the rest of the body. Head-capsule is foveate and flat with a wide mid-ventral gap accommodating the labio-maxillary plate. Posteriorly the head-capsule is connected on the ventral side by a chitinous bar, the gular bridge. The median ill-defined epicranial suture divides the head-capsule into a median dark frontal and lateral parietals. The frontal is deeply notched anteriorly by the V-shaped fronto-clypeal suture, beyond which lies the triangular and centrally infuscate clypeus. The parietals extend anteriorly up to the base of the antenna and are separated from the ventro-lateral genæ by a longitudinal suture. A fuscous black eye-spot occurs at the anterior margin of each parietal. Antennæ are six-jointed and take their origin from the head-capsule in between the lateral margin of the clypeus and the front margin of the parietals. Each antenna is placed over a short, stout, whitish basal piece which Paiva (1919) describes as the basal antennal joint. This is not a true joint but only the membranous antacoria into which is the antenna often telescoped. The true basal antennal point (the second joint of Paiva) is as long as or slightly longer than all the remaining joints put together. It is little chitinised but bears anteriorly a few rufous hairs. Beyond this there are five small distinct, strongly chitinised joints, each with a few delicate hairs. The distal joint is rounded and unimucronate and carries two conspicuous rufous hairs. Paiva appears to have missed one of these joints and so he also describes the antenna as six-jointed. Mandibles are dark reddish brown, falcate, and without the mandibular canal so characteristic of the larva. The mandibles articulate with the head-capsule both dorsally and ventrally by strong condylar articulations. The mandibular postartis is rounded and articulates with the acetabulum in the genal postcoila. The hypopharynx, mandibular appendages and other tufts of stiff hairs of the larvæ appear to be very much reduced. The labio-maxillary plate consists of the narrow median labium and the stout lateral maxillæ. The base of the maxilla is formed of the small cardo and the large stipes which is very slightly and irregularly chitinised and carries a strong ventral spine. The maxillary palp is stout, strongly setose and four-jointed, of which the penultimate joint is very narrow and the distal one globular with a bright oval sensory streak. The galeæ are two-jointed with the distal joint carrying a few tactile hairs and the basal joint with a row of about five stiff hairs. Internally the galeæ form two sharp cutting edges. The labium is divided into a prelabium and a postlabium by the labial suture. The postlabium includes the mental and the submental regions. The postlabium in the larva is strengthened by a single postlabial sclerite which represents both the mentum and the submentum. In the female the submentum is not chitinised but the mentum is strongly chitinised into a long cylindrical posteriorly narrowed sclerite. The prelabial sclerite is strong. The labial palp is two-jointed, the basal joint being stouter than the distal. The prelabium bears dorsally a median cutting edge which works along with those of the maxillary galeæ.

Thorax.—The terga are feebly channelled by a mid-dorsal sulcus. The pronotum is beautifully arched in front and broadened posteriorly with a slight elevated disc in the middle and ventro-laterally depressed lateral areas. The meso and metanotum are not arched but are sub-rectangular with lateral margins rounded.

Pronotum—*l.* 10 mm.; *b.* 14 mm. Mesonotum—*l.* 8 mm.; *b.* 18 mm. Metanotum—*l.* 8 mm.; *b.* 20 mm.

The marginal ridge of the terga is strongly developed round the anterior border of the the pronotum. Ventrally the sclerites are ill-defined. Thoracic legs have well-developed tarsi. All the legs are more or less similar. Coxa stout. Coxo-trochanteral articulation dicondylic. Postcondylar trochanteral area rounded. Trochanter long and narrowed distally with a distinct transverse suture dividing it into two sub-joints, the proximal joint carrying the condyles for coxal articulation and the distal immovably fixed with the femur.

Femur stout and broad distally with two prominent rows of hairs. Tibia cylindrical and narrow. Femoro-tibial articulation dicondylic. Tarsus four-jointed, basal three joints piceous and small and distal joint very long and stout with two strong claws.

Abdomen.—Abdomen consists of nine distinct segments. The abdominal terga form a row of imbricate plates. All the plates except the ninth are channelled by a mid-dorsal sulcus. The posterior plates have their postero-lateral areas more rounded. Ventrally the sternal plates are roughly rectangular and each is provided with four longitudinal ridges each carrying a row of soft spines. The pleurites are squarish plates carrying the spiracles. The pleurites of the penultimate segment are 'eburated' (Gorham, H. S., 1880) and form the photogenic area. The last abdominal segment carries the anal brush.

Internal Anatomy.—Immediately beneath the tergal plates is an extensive sheet of adipose tissue, below which is the massive ovary extending into the thorax and even into the cervix. The alimentary canal lies considerably flattened under the ovary. The long narrow œsophagus runs from the pharynx to a small sac-like pouch which leads into an elongated depressed and almost empty mid-intestine, whose walls carry longitudinal folds. The mid-intestine is followed by the coiled intestine. Four Malpighian tubules occur. Below the alimentary canal is the long chain of ganglionated double ventral nerve cord. The thoracic and abdominal ganglia are similar in size. The pro-, meso- and metathoracic ganglia supply the three pairs of legs. The metathoracic and first abdominal ganglia are close to each other. First five abdominal ganglia are very distinct, placed uniformly apart and supply the spiracles. The remaining abdominal ganglia are crowded and very close to each other. Below the nerve cord is another layer of fat.

Dept. of Zoology,
Madras Christian College,
Tambaram, J. Samuel Raj.
May 10, 1943.

1. Austin, G. D., "The Indian Glow-worm (*Lamprophorus tenebrosus* Wlk.)," *Year Book, Dept. Agric., Ceylon,* 1921. 2. Gorham, H. S., "Materials for a revision of the Lampyridæ," *Trans. Ent. Soc. London,* 1880. 3. Gravely, F. H., "Notes on the habits of Indian Insects, etc.," *Rec. Ind. Mus.*, 1915, **11**. 4. Hutson, J. C., and Austin, G. D., "Notes on the habits and life-history of the Indian Glow-worm," *Dept. Agric. Ceylon Bull.*, 1924, **69**. 5. Paiva, C. A., "Notes on the Indian Glow-worm (*Lamprophorus tenebrosus* Wlk.)," *Rec. Ind. Mus.*, 1919, **16**. 6. Raj, J. S., "On the mouth-parts of the Indian Glow-worm, *Lamprophorus tenebrosus* Wlk.," *Curr. Sci.*, 1943, **12**, No. 3.

FLUCTUATION IN THE WEIGHT OF A PLANT

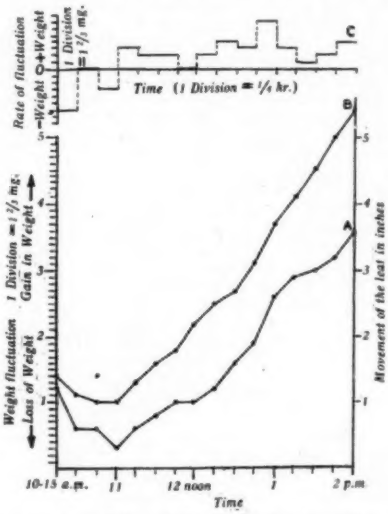
Although extensive work has been done by Miller (1925) and others[1] on the increase in the weight of a plant at intervals of a week or more, still no reference is noticed on the fluctuations in weight at short intervals. In his papers on leaf movements the author[2,3] has mentioned that this movement is brought about by the variation in the turgidity of the plant body, indicating a fluctuation in the water content of the plant. Further work done in this line denoted a relationship between the direction of leaf movement and the fluctuation in the weight of a plant, whether the plants were exposed to natural light or artificial light. The author's observations on *Lycopersicum esculentum* are mentioned in the following note.

The potted plants, about twenty days old, were selected for observation. Since the leaf movement and weight fluctuation could not be studied from the same plant at the same time the two aspects had to be studied from different plants exposed to similar external conditions. The plant for the study of weight was removed from the pot, and its root system was carefully washed before the plant was weighed. The weight of the plant was 1·253 gm. The solution for the plant was prepared from the manured soil in which the plant was growing, and was thoroughly aerated. The plant was suspended from the beam of a balance but enabled the root system to be within the soil solution in a trough free from the balance. This enabled the free movement of the beam and the connected lever. By a suitable arrangement the level of the solution was maintained constant. Actual recording was started about an hour or more after setting up the experiment. The recording was done between 10-15 a.m. and 3 p.m. (new time), with the plants exposed to the sky light from the northern window, but not to direct sun. The room temperature, which was 77° F. when the experiment was started, showed a rise of 2° F. in the course of six hours, the first perceptible rise being after 12 noon. Readings were taken at intervals of 15 minutes with the help of levers magnifying 15 times. The three graphs A, B and C are drawn to a magnification of 75.

The weight curve (A) shows that the plant was losing weight till about 11 a.m., and that after this there was a continuous increase in weight. The graph for the leaf movement (B) indicates that the leaf also changes its direction of movement about the same time, the upward and downward movement of the leaf thus coinciding with the oscillation in the weight of a plant. Graph C explains the rate of change in the weight of a plant.

The above observations prove that although the plant shows an increase in weight from day to day, still it will be losing weight during certain hours of the day. The movement of the leaf directly signifying a variation in the turgidity of the plant-body at regular intervals, may also be taken to be an indirect expression of the fluctuating weight of the plant

mostly due to the variation in water content. In conclusion it may be stated that this highly



Graphs to explain weight fluctuation in a plant.
(*Lycopersicum esculentum*)

A. Graph to show variation in weight. × 75
B. " " " leaf movement × 75
C. " " " rate of variation in weight × 75

interesting feature happens to be a normal occurrence in the daily life of this plant.

A paper dealing with this aspect in several plants will be published later.

Department of Botany,
Intermediate College,
Mysore, C. V. KRISHNA IYENGAR.
May 12, 1943.

1. Miller, E. C., Unpub. data, *Kans. Agr. Expt. Sta.*, 1925. 2. Krishna Iyengar, C. V., *Jour. Mys. Univ.*, 1942, **3**, 23-38. 3. Krishna Iyengar, C. V., "Rhythm in the leaf movement" (sent for publication), 1943.

THE BLOOD GROUPS OF THE DOMS

DR. D. N. MAJUMDAR (*Man in India*, Dec. 1942) has again raised the question of illegitimacy among the Doms (*Current Science*, April 1942) as found by him through blood groups, without adducing any new relevant data whatsoever. Since it is known that theoretically exceptions to the laws of Bernstein might result from mutations and the chromosomal aberration, known as non-disjunction, it is desirable that the detailed data be published, so that no room is left for any of the above causes. Attention may here be drawn to the exceptions of Bernstein's laws found by other workers (Wiener, 1935) and it would be worthwhile to examine Dr. Majumdar's results in the light of these known exceptions.

Bose Institute,
Calcutta,
March 9, 1943. S. S. SARKAR.

Wiener, A. S., *Blood Groups and Blood Transfusion*, 1935.

THE paper under reference (*Man in India*, December 1942) is a detailed account of the Doms and their Blood Groups which was briefly inserted in *Current Science*, April 1942.

I did not 'raise any question of illegitimacy among the Doms' but merely stated facts. The cases that could be detected were not more numerous than could be explained by illegitimacy. The people who were examined and whose bloods were of doubtful affiliation in the majority of the cases, themselves affirmed my suspicions.

Every serologist working in Blood Groups, is expected to know the theoretical limitations of Bernstein's laws but where such obvious evidence exists, I think, there is no necessity of assuming chromosomal aberration or mutation. Snyder has pooled (1929) the extant data on the subject collected by a large number of different investigators. Out of 1,600 offsprings in 571 unions between individuals belonging both to Group I in Jansky's classification, 27 were found to belong to one of the remaining groups. This was not considered by Lancelot Hogben as due to chromosomal aberration or mutation but he traced these to illegitimacy and occasional failure of test. (*cf.* Lancelot Hoben, *Genetic Principles in Medicine and Social Science*, pp. 68-90.)

The relevant data can only be published on two conditions being fulfilled, *viz.*, (1) space made available in some scientific journal, (2) immunity against legal proceedings being guaranteed. As both the conditions are difficult to satisfy immediately, I am afraid Mr. Sarkar will wait. Mr. Sarkar knows that the entire blood group data (about 5,000 samples already tested) collected in connection with the anthropometric survey of the U.P. will very soon be published in the Report under preparation and if he can wait, *he would be able to pronounce his verdict on the 'relevant data'*.

Anthropological Laboratory,
Lucknow University,
March 22, 1943. D. N. MAJUMDAR.

REVIEWS

Mass Spectra and Isotopes. By F. W. Aston. (Edward Arnold and Co., London), 1942. Pp. xii + 276. Price 22-6-0.

This is a very readable book written with authority by one who is master of the field. It is not a treatise on the subject in which every development is dealt with in equal detail, but is written, rather, from a more personal angle, and since the personality of the author has occupied a central position in the field from the beginning, a very balanced account of the whole development of the subject from its inception to its present more or less completed stage has resulted. The book is in four parts, and is illustrated with twelve well-chosen plates.

The first part traces the history of the subject, which really entered its modern stage when the idea of isotopes was put forward by Soddy in 1910, up to about 1925. There is a chapter devoted to a description of the details of Aston's first mass spectrograph and an elementary account of the theory underlying it. I feel, however, that the full mathematical theory of the spectrograph as worked out by Aston and Fowler should have been given in the book for the benefit of those who wish to understand the working of the instrument in greater detail, and this might well have been done in an appendix in order not to encumber the text. Similarly, the questions of dispersion and resolving power might also have been treated at greater length.

The second part of the book deals with the modern technique of mass spectrography and the development of high precision instruments. It is a very well written survey of the field which enables the reader to appreciate the triumph of modern technique in the enormous increase in the precision of the modern instruments over the original mass spectrograph.

The third part of the book is a most useful and authoritative compilation and deals with each element in the order of its atomic number. For each element all the known stable isotopes, and of the naturally radio-active substances, those stable enough for mass spectrum analysis, are mentioned, and the best figures for their relative abundance and packing fractions, when known, are given. In the words of the author, "This account constitutes a summary with references, of all the data upon which have been based the first International Table of Stable Isotopes in 1936 and each of its annual publications since". It forms a most useful place of reference for the research worker in the field, whether experimental or theoretical.

The fourth part of the book deals with several distinct themes. There is an elementary chapter on modern ideas about the structure of nuclei. In this connection I doubt the wisdom of publishing a diagram like Fig. 37, which might give to the beginner a completely outmoded picture of the atom, when with the help of the ideas of state, energy and angular momentum an accurate knowledge of the atom could have been conveyed with equal simplicity and at hardly greater length. There is a very good chapter on the isotopic effect in molecular spectra, and one on the isotopic effect in atomic spectra and the allied properties of nuclear spin. Finally there is a good chapter on the separation of isotopes. I think that the separation of isotopes by electrolysis is of sufficient importance to have merited a more detailed description of its technique, since it is the application of this method to the isotopes of hydrogen which has led to the only complete separation of a rarer isotope on a large scale that is so far known.

The author is to be congratulated on having treated a bulky subject in such a clear and simple way and yet with completeness in its main essentials. The above remarks have been made merely as suggestions, which might be considered when a new edition is contemplated, in order to increase the completeness and usefulness of what is really an *excellent* little book. The book is to be warmly recommended not only to the student, but also to the theoretical physicist who wishes to get a knowledge of the methods and experimental results from which the facts upon which he builds his theories are derived.

H. J. BHABHA.

Polarography. By I. M. Kolthoff and J. J. Lingane. (Interscience Publishers, Inc., New York, N.Y.), 1941. Pp. xvi + 510, with 141 illustrations. Price $6.00.

The book is intended "to present a complete and critical account of the present status of polarographic analysis ... and the newly developed 'amperometric titration' methods". The book is divided into eight parts and thirty-three chapters. The captions of these eight parts indicate the subject-matter of the book and are: Introduction; Theoretical Principles; Apparatus and General Technique; Inorganic Polarographic Analysis; Organic Polarographic Analysis; Biological Applications of Polarography; Voltammetry with Platinum Microelectrodes; Amperometric Titrations.

The theoretical principles underlying these methods of analysis have been treated in some detail and the experimental evidence on which they are based have been amply cited. The recent work of the senior author and his collaborators have been drawn upon extensively. The book gives a full account of the present position of our knowledge regarding polarographic analysis. It will be found very useful by those interested in this branch of electrochemical analysis and more particularly by research workers in this subject. Its very wealth of detail, however, may cause embarrassment to those who are concerned more with the use of the method than with the details of numerous investigations some of which have

not passed beyond the formative stage of development. It would be of great advantage if the subjects were presented in the next edition in two parts, one giving a brief outline of the theoretical principles, just sufficient experimental details for accurate results and only those examples of analyses where these methods have been found to be reliable and most useful. Detailed theoretical treatment and the various applications where the method does not yield results which are quite unequivocal might be dealt with in the other part. The theoretical background of the whole subject though it has been considerably cleared up by recent work seems to admit of considerable improvement in many places. One such topic is the interpretation of maxima. The fundamental relations in section 6 of the second chapter would, it is hoped, in due course be capable of a more direct theoretical treatment. One would have liked a more comprehensive discussion of the investigations on the electro-capillary curve which, as the authors have indicated, is of utmost significance in polarographic work.

Taking all in all, however, the book is a welcome publication and illustrates the great progress made in the development of these methods and their utility in which the authors and their collaborators have actively participated. In addition to the subject and author indices there is an appendix containing half-wave potentials of inorganic substances which will be found to be very useful.

The reviewer regrets the delay in reviewing the book partly due to pressure of work and partly for other reasons. J. N. M.

Electrical Engineering Practice, Vol. II. By J. W. Meares and R. E. Neale. (Chapman & Hall Ltd., London), 1942. Pp. xii + 663, Figs. 244. Price 35*sh*.

This is volume number two of the well-known work of the authors which is now running in its fifth edition and which is published in three volumes. The first volume was published a year earlier.

Volume two, as it appears in its present form, is an improved and enlarged edition of the previous one. The contents and the index are so arranged that they form one single unit for the three volumes together. Further, reference is to numbered paragraphs and not to pages. There are in all 1060 paragraphs of which the first 386 are in volume I and 669-1060 in volume III and the rest in the volume under review. The subject-matter included, therefore, is divided into three parts called parts IV, V and VI and it runs through eleven chapters in all, beginning with chapter 17 and ending with chapter 27. Part IV deals with transformation, conversion and storage of electrical energy; part V deals with distribution and control in branch circuits; and finally, in part VI are given the applications of electrical energy.

The book is packed with useful and valuable information. It has been brought up-to-date and one distinctive feature about it is that although it deals essentially with modern practice still it gives wherever necessary information about the older practices on which later practices are based. This is a book which will be found of great help to every engineer—whether electrical, mechanical or civil. It has all the advantages of a hand-book without its disadvantages. The field covered is very large and yet it is written in such a way that whatever the topic that is being discussed, the reader gets the impression that he has been given a good bit of information which he can understand and which will be of definite use to him. The balance that has been achieved between what one calls 'theoretical' and what one calls 'practical', makes the book unique.

There are plenty of illustrations included in the text as also a large number of tables which give information not easily accessible. At the end of each chapter a more or less exhaustive bibliography is given which makes the book still more valuable.

In conclusion, in the opinion of the reviewer, this book is meant for an engineer whose duties demand from him both technical knowledge and experience. Money spent in buying these volumes is money well invested.

Prakashlekhan Shastratil Ascharye. By K. A. Damle, B.SC. (Published by the author at Damelewada, Shastripol, Baroda), 1943. Pp. 156, Figs. 39. Price Rs. 2.

This little volume of 156 pages written in Marathi, is not exactly a treatise on photography and allied subjects although it contains a lot of information. It is essentially meant for the general reader. It is written in an easy style and succeeds in keeping the interest of the reader throughout.

The book can roughly be divided into two parts. The first part which covers four chapters unfolds the remarkable story of the birth and growth of the science of photography. The rest of the book is devoted to a number of topics connected with photography the range of which is suprisingly wide. Here are some of the items dealt with: Cinematograph, talking pictures, trick photography, colour photography, X-ray, infra-red, ultra-violet photography, spectro- and micro-photography, photostat, etc. The reader will find something interesting to read about almost every one of these.

The author has done a distinct service to the Marathi reading public in writing this interesting and instructive book.

A Text-Book of Intermediate Physics in Tamil, Vol. II. By R. K. Viswanathan and V. N. Ramaswamy. (Annamalai University, Annamalainagar), 1941. Pp. lxxi + 689-1372 + xii.

This is a successful first attempt at writing the more advanced general science in Tamil. The book is written in free Tamil and the presentation of the subjects, light, sound, magnetism and electricity, follows the routine text-book type. The scientific equivalents coined

are mostly simple and intelligible. However, it would be proper to select a few of these which, in the reviewer's opinion, are not satisfactory. Projecting lens is 'வீச்சு வில்லை', while projection is 'வீழ்ச்சி' and also 'வீச்சு' is 'amplitude'. Barium is 'பாரியம்' on page 1312 and 'பேரியம்' on page 1330. The reviewer does not also feel happy about the use of both Tamil and English letters in the same figure or equation. There are a number of typographical errors and indiscriminate uses of bold printing, though these do not seriously mar the usefulness of the book. It is to be regretted that a text-book on Physics for Intermediate should be so badly illustrated. An English to Tamil glossary would add to the value of the book.

V. S. G.

Marriage and Family in Mysore. By M. N. Srinivas. (New Book Co., Bombay), 1942. Pp. 218. Price Rs. 7-8-0.

There was a time when, for anthropological information concerning India, the student of the subject had to depend entirely on workers in European Universities and foreign periodicals such as *Anthropos* and *Man*, but since Risley started the ethnographic survey of India, the position with regard to field data steadily improved, though their interpretation and analysis lagged behind. To draw conclusions and arrive at generalisations from a mass of ethnographic material is not an easy task, but to be useful it has to be accomplished in the light of general anthropological theory. Scientific anthropology begins only when regional data can be fitted into those for the whole world. For the anthropology of Mysore, the book under review marks the beginning of the interpretational phase. The Bombay University and Prof. G. S. Ghurye have to be thanked for helping the production of this book; while South Indian Universities are treating Anthropology in a step-motherly fashion, the Bombay University seems to show a better appreciation of its value as a scientific discipline. As the Vice-Chancellor of the Mysore University remarks in his Foreword, "Works on Indian Sociology based on careful field study are not very common yet". Man, before he can plan the future or order the present, should know himself. There may be some who might be inclined to regard the theme of this book as banal. The reviewer would ask any Mysorean who holds such a view this simple question: "How many of you who have worn the *Bhashinga* or sat behind the 'milk-post', or tied a *tali* know their full meaning? If you do not know it, look for it in the pages of Mr. Srinivas's book." In nineteen brief chapters, he discusses the institution of marriage in Mysore as it affects its various tribes and castes, and in all the chapters there is something that will interest every class of readers.

For his material, the author depends chiefly on *Mysore Tribes and Castes* and *Mysore Gazetteer*, but whereas these pioneer works are on the observational level, Mr. Srinivas deals with the rites, practices and the various sociological situations at a deeper level. Occasionally he disagrees with the meanings given to some rituals by the earlier writers, and most often he is right. This means no disparagement to the senior workers, for anthropology has outgrown such theories as universal matriarchate, primitive communism, promiscuity, etc. Quite correctly Mr. Srinivas has tried to evaluate the information at his disposal and pointed out where it is incomplete or defective.

Hindu Culture in Mysore is divided into a top-grade—Sanskritic as Mr. Srinivas styles it; a middle grade of mixed composition to the Sanskritic veneer of which constant addition takes place due to the uncritical borrowing by non-Brahman castes of Brahman practices; and low grade, the carriers of which are the primitive tribes. The otherwise static institution of marriage is complicated in the middle grade by the imitativeness of non-Brahman communities and the changes are always fatal in their effect on the position of women. Mr. Srinivas issues a warning against this, but social changes would still go on unregulated unless the people themselves realise that the consequences of these unconscious innovations are deleterious.

The subject matter of the book is difficult to summarise and the reviewer can only recommend it to those interested in Sociology in general, and to Mysoreans in particular.

A. A.

School and College Libraries. By S. R. Ranganathan. The Madras Library Association), 1942. Publication Series No. 11. Printed by Thomson and Co., Ltd., Madras. Pp. 432.

As Mr. John Sargent says in his Foreword to the book, Mr. S. R. Ranganathan needs no introduction to the reading public of India. The present one is, in fact, the tenth of his books on Library Technique. The book is the product of the realisation by the author of the potency of a well-equipped library in stimulating the self-educability of students of the various school and college standards.

The book consists of six parts and twenty-seven chapters; it commences with the chapter on "Why" of school libraries and proves the important place that the school library should occupy in the education of the individual as this alone leads to life-long self-education. In the chapters that follow are given useful information as to what an Elementary School and a High School library should be, how books should be arranged in the libraries, what books there should be, how they should be classified and so forth. Details regarding book selection, accessioning and numbering work are also given. There is also a useful index at the end of the book.

Libraries hold an honoured place in the cultural economy of the great nations of the world. In fact, the libraries should be regarded as people's universities. It is a fact that in India libraries have not yet gained the importance they deserve to have. Mr. Ranganathan's books are sure to stimulate opinion in favour of a strong library movement and help to organise library work on scientific lines.

B. V. SASTRY.

CENTENARIES

Gill, David (1843–1914)

SIR DAVID GILL, a British astronomer, was born in Aberdeen, 12th June 1843. His inspiration to scientific studies, he owed to Clerk Maxwell while at the University of his place. He took charge of his father's business which was watch-making; but he devoted his spare time to the pursuit of science.

In 1863 his desire to provide his town with time service similar to the one at Edinburgh, led him to re-establish a disused observatory at the University and he fitted up the necessary instruments and established electric control of the important clocks of the town. This venture led him more into astronomy and with instruments made by his own hand, he soon began observations of double stars.

In 1870 he took charge of the private observatory started by Lord Lindsay. Besides fitting up, he went to Mauritius with about fifty chronometers to observe the transit of Venus in 1874. His work there is said to have inaugurated a successful method to find the sun's distance.

In 1877 he set up an observatory at the island of Ascension to measure the distance of Mars when it came exceptionally near the earth. His tenacity is shown by his managing to shift the observatory to a new place in five days' time to avoid cloud banks that obstructed. The sun's distance was again determined with a greater accuracy.

In 1897, Gill was appointed astronomer at the Cape of Good Hope. The Observatory had then only one instrument. But when he left in 1907, he left it fully equipped with modern instruments and a fully qualified staff to carry out work of the highest order. During his period of office, he measured the distances of twenty-two stars and made an era in the measurement of stellar distances. In 1889 he redetermined the sun's distance correct to one point in a thousand. Gill was also a pioneer in the application of photography to astronomy. In 1885 he began a photographic survey of the southern sky. The results published in the *Annals* of the Cape Observatory show the positions and magnitudes of about 400,000 stars. This great survey formed the basis of important investigations in the distribution of stars. Gill took part also in the triangulation of a large part of Africa.

After his retirement, Gill wrote his *History and Description of the Royal Observatory, Cape of Good Hope*, and it was published in 1913.

Gill was knighted in 1900 and was President of the Royal Astronomical Society and of the British Association for the Advancement of Science.

Gill died of pneumonia in London, 24th January 1914.

University Library,
Madras,
June 4, 1943.

S. R. RANGANATHAN.

SCIENCE NOTES AND NEWS

Conversion of Town Wastes into Agricultural Manure.—The Government of India have recently sanctioned a grant of Rs. 1,86,000 to the Imperial Council of Agricultural Research for introducing into municipal areas an improved method of converting town wastes into good quality agricultural manure by the process of composting. A large amount of work on composting has been carried out both in this country and elsewhere; particular attention should, however, be invited to the pioneering researches of Fowler, Howard and their associates as also to the work of the various agricultural departments in the country. Investigations had been going on at the Indian Institute of Science, Bangalore, on the above subject for a number of years, under the auspices of the Imperial Council of Agricultural Research, which showed that the methods till now recommended for the composting of town wastes were defective in that (*a*) most of the methods involved frequent turning-over of the mass, which promoted excessive aeration and rapid loss of moisture, and also resulted in increased smell and fly-nuisance; and (*b*) such turnings and aerobic conditions resulted also in heavy losses of valuable manurial constituents such as nitrogen and organic matter, to the extent of even more than half of the quantities originally present; and (*c*) further, such turnings meant increasing the cost of composting operations two- or three-fold, and thus rendering the manure too costly for purchase by our ryots.

As a result of detailed work on the subject carried out at the Institute by Dr. C. N. Acharya, a simple and satisfactory technique of compost-making was finally evolved, which dealt with town wastes such as *katchara* (sweepings and dust-bin refuse), night-soil, sewage and slaughter-house refuse, and converted them into good quality manure and at the same time fulfilled all the essential requirements of compost-making, such as:—(*a*) low cost of operations and cheapness of the product obtained; (*b*) completely sanitary and hygienic conditions, secured by rapid development of high temperatures above 70° C.,

which effectively destroyed fly-larvæ, pathogenic organisms, weed seeds and abnoxious constituents of town-refuse and night-soil; and (c) minimum losses of organic matter and of nitrogen.

The above process has been tested widely in the Bombay Province during the last one year, by nearly fifty municipalities in the Central and Northern Divisions, and has been adopted for routine operation by several of them, with highly successful results from the economic and sanitary points of view.

The present grant has been given by the Government of India with a view to extending the work carried out in the Bombay Province to other Provinces and States in India, and as a first step thereto undertaking the training of officers deputed from different parts of the country in the improved process of compost-making. It has been calculated that if the total urban refuse available in urban areas in this country could be converted into manure, it would ultimately be possible to supply nearly a crore of tons of good quality manure for agricultural purposes. Organic manure is of special importance in our tropical soils in improving the physical, chemical and biological properties of the soil and thus improving crop yields. If a cheap source of organic manure could be had from our town-refuse, it would go a great way to recoup the continuous drain which the towns are exerting on the surrounding agricultural area, and to stem the slow and steady deterioration that is taking place in the cropping capacity of our soils.

The main source of manure at present available for agricultural purposes is farm-yard manure, but the method of preparation adopted by the farmers in most areas of India is defective in that (a) the valuable urine fraction of cattle-excreta, which is rich in nitrogen, is almost completely lost; and (b) under the present arrangement of storage in big-sized round or square pits, the manure gets rapidly dried in the summer and washed by rain in monsoon time, involving in both cases loss of nitrogen and defective decomposition. Dr. Acharya has also developed an improved technique for the preparation of farm-manure by agriculturists, in which long trenches are used, which are filled up in portions from one end and plastered over with earth.

If the above improved methods for dealing with town and farm-wastes respectively, could be propagated widely in this country, it is felt that crop yields could be increased to such a level that the food problem would be automatically solved.

Lateral Eccentricity in a New Species of Pachydiscus from the Trichinopoly Cretaceous. Mr. G. Rukmangada Rao, Andhra University, Guntur, writes:—Lateral eccentricity of the shell has been previously observed in the Nautiloidea from the Cretaceous rocks of Trichinopoly. It is not infrequent in this order from these rocks. I have observed lateral eccentricity in a species of *Pachydiscus*, an ammonite from the Ariyalur group. By virtue of its recognition for the *first time* in the *ammonoidea* from these rocks and the differences this species has with the associated species, it has been isolated as a new species of Pachydiscus and called *Pachydiscus eccentricensis*. The type specimen is preserved in the Department of Geology, Benares Hindu University.

Soil Erosion in India.—Soil erosion, resulting from the neglect or destruction of the plant cover of hillsides, threatens to lay waste large areas in India, particularly in the foothills of the north and in parts of Central India. Not only would land in the hills be rendered useless for agriculture and growing timber but flood disasters in the plains would become more frequent and of greater magnitude, while irrigation supplies in the dry season would be reduced.

A note in Bulletin No. 37 of the Central Board of Irrigation stresses the need for a central co-ordinating authority to check erosion, pointing out that it is in the upper reaches of catchment areas, possibly lying within the territories of several States, where preventive measures are required and that with so many interests co-operation in a common policy is essential. The Board of Forestry has suggested the division of India into 13 units, each representing the catchments of a river or group of rivers and placed under a special officer to work in co-operation with the Forest, Agricultural and Irrigation Departments. With the willing co-operation of the Provinces and States concerned, large-scale measures can be organised to remove the threat of mass devastation and undo some of the evil caused by past neglect.

U.K.-U.S.A. Steel Mission.—Members of the U.K.-U.S.A. Steel Mission arrived in New Delhi this afternoon (June 4) for consultations with the Government of India. After a stay of about three days in New Delhi they will proceed to Calcutta for discussions with the Director-General, Munitions Production, and the Iron and Steel Controller.

The Members of the Mission are:—Sir John Duncanson, British Controller of Iron and Steel Supplies; Mr. Norman Anderson of the British Steel Control; Mr. A. E. Emerson, President of the American Rolling Mill Company; and Captain A. H. Gaal, a Metallurgist from the U.S.A.

The Mission has already visited the U.S.A. and Australia, and will proceed to South Africa after a short stay in India.

The purpose of their tour is to secure increased co-ordination of the Allied resources of steel supplies with the needs of all the Allied countries, and to discuss other more detailed problems concerning steel supplies in each country.

Cardboard from Coconut Fibre.—A new enterprise for manufacturing cardboard from coconut fibre in Ceylon has, it is reported, proved highly successful. The scheme was developed by Mr. S. R. K. Menon, an Indian Chemist, with the financial assistance of the Coconut Board of Ceylon. After certain preliminary experiments a pilot plant was established in Colombo and it is now able to turn out cardboard of high quality with a polished

surface. Proposal for manufacturing the material on a commercial scale is likely to be considered shortly by the Coconut Board. The new product is called 'Coconite'.

Lady Tata Memorial Trust.—The Trustees of the Lady Tata Memorial Trust announce the Awards of the following Scholarships and Grants for the year 1943-44.

I. International Awards for research in diseases of the blood with special reference to Leucaemias.

1. PROF. L. DOLJANSKI of Jersualem: To continue studies on (1) Leukotic cells and agent of fowl leukosis *in vitro*; (2) The X-ray susceptibility of leukotic agent; (3) The cell affinities of oncogenic viruses and the mutual relationship between Rous Sarcoma agent and agent of fowl leukosis. (*Grant of £400, Second Year's Award.*)

2. DR. JACOB FURTH, of American nationality, Cornell University Medical College, New York: To continue the work in progress upon the Leucæmias like diseases of fowls and their relation to neoplasms and to determine the nature of viruses producing leucæmias and associated neoplasms lymphomatosis, myelomatosis, endothelioma, sacromas, etc., etc. (*Grant of £300, Ninth Year's Award.*)

3. DR. P. A. GORER, Guys Hospital, London: To continue the studies in the genetics of mouse Leucæmia. (*Grant of £70, Fourth Year's Award.*)

4. DR. A. H. T. ROBB-SMITH, Nuffield Reader in Pathology and Morbid Anatomy, Oxford University: To continue the aid to the establishment of a "Lymphonode Registry" in the School of Pathology at Oxford to aim at better classification and follow up of human cases showing progressive hyperplasias and neoplasms of the lymphoreticular tissues including cases of the leucæmias, lymphadenoma, lympho sacroma, etc. (*Grant of £350, Fourth Year's Award.*)

5. DR. WERNER JACOBSON, Part-time Sir Hailey Stewart Fellowship at the Strangeways Research Laboratory, Cambridge: To continue the study of making a histo-chemical study of the argentafine cells of the gut epithelium, with a view to determining whether they are the source of the intrinsic factory of castle, and hence their bearing on the problem of pernicious anæmia and other blood diseases. (*Grant of £300, Sixth Year's Award.*)

6. DR. SYBIL WILLIAMS, Cambridge: To assist in the work of Dr. Werner Jacobson. (*Grant £400. Third Year's Award.*)

II. Indian Scholarships of Rs. 150 per month each for one year from 1st July 1943 for scientific investigations having a bearing on the alleviation of human suffering:—

1. MISS MARY SAMUEL, B.A., M.Sc.: To continue the research work on the effect of fat-soluble vitamins on the histology and cytology of the female gonad, under Prof. R. Gopala Aiyar, Director, University Zoological Laboratory, Madras. (*Second Year's Award.*)

2. MISS BEATRIZ DE MENEZES BRAGANCA, M.Sc.: To continue the work on Dietary factors in relation to Hæmopoiesis, under Prof. B. C. Guha, D.Sc. (Lond.), Ph.D., Head of the Department of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta. (*Second Year's Award.*)

3. MR. M. V. LAKSHMINARAYANA RAO, M.Sc.: To continue the research work on Insulin, Carbohydrate metabolism and the cure of Diabetes, under Dr. V. Subrahmanyan, D.Sc., F.I.C., Professor of Bio-Chemistry, Indian Institute of Science, Bangalore. (*Second Year's Award.*)

4. MISS B. S. ALAMELA, B.A., M.Sc.: To work on Synthesis and Biological Study of Sulphanilamide Derivatives, under Lt.-Col. S. S. Sokhey, M.D., I.M.S., Director, Haffkine Institute, Parel, Bombay. (*First Year's Award.*)

5. MR. AROBINDA ROY, M.Sc.: To carry out investigations on (*a*) The absorption rate of different edible oils used in India and the effect of Vitamins A and D and hydrogenation; (*b*) The metabolism of fat in some pathological conditions, namely, in experimental anæmia and diabetes and diphtheria toxæmia; (*c*) The determination of different components of the phospholipides in human blood in some pathological conditions, under Dr. B. B. Sarkar, D.Sc., F.R.S.E., Head of the Department of Physiology, University College of Science, 92, Upper Circular Road, Calcutta. (*First Year's Award.*)

6. MISS VIOLET DESOUZA, M.Sc.: To carry on investigation of a few promising strains of yeasts and their hybrids as sources of the Vitamin B complex, under Sir Jnan Chandra Ghosh, Kt., D.Sc., F.N.I., Head of the Department of General Chemistry and Director, Indian Institute of Science, Bangalore. (*First Year's Award.*)

University of Ceylon.—Under a new statute recently made by the University Court the following are now added to the degrees which the University may confer: Bachelor of Dental Surgery (B.D.S.) and Master of Dental Surgery (M.D.S.). It may be noted that these degrees are not conferred by many of the Indian Universities.

The University Senate has, it is learned, recommended the creation of four professorial chairs in Oriental Faculties for Sinhalese, Tamil, Pali and Sanskrit. It is possible that the Chair for Sanskrit may be filled from India.

A convocation of the University is to be held this month for the purpose of conferring degrees gained in recent examinations.

Indian Mathematical Society: Conference at Annamalainagar.—The authorities of the Annamalai University have invited the Indian Mathematical Society to hold its next conference at Annamalainagar about the end of December 1943, and the Society has accepted the invitation. It is also proposed to hold, in connection with the Conference a mathematical exhibition intended to illustrate the richness and variety of the subject and the wide range of its applicability to life situations. Suggestions regarding suitable items, as well as charts, models, instruments and other exhibits will be gladly received and exhibits on loan duly acknowledged and returned at the end of the Conference. It is also proposed to have a "book section" for exhibiting books on

mathematics. All correspondence relating to the Conference, and all papers to be read at the session may kindly be sent (with two short abstracts of each paper) to Dr. A. Narasinga Rao, Annamalainagar P.O., South India. It is hoped that, in spite of the difficult conditions under which the Conference and exhibition are held the enthusiasm and co-operation of members will make the venture a great success.

The Travancore University.—We are glad to announce that Dr. C. S. Venkakteswaran, M.A., D.SC., has been appointed as Professor of Physics in the Travancore University. He will be placed in charge of the organisation of the newly started M.Sc. courses and will guide other post-graduate researches. Dr. Venkateswaran has been working in the Indian Institute of Science for the past ten years under the inspiring guidance of Sir C. V. Raman and has contributed several important papers on Raman Effect, Molecular Scattering of Light, X-Rays and other allied topics.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory, Bombay, during the month of May 1943, there were one of moderate and two of great intensities. The details for those shocks are given in the following table:—

Date	Intensity of shock	Time of origin I.S.T	Epicentral distance from Bombay	Depth of focus	Remarks
		H. M.	(Miles)	(Miles)	
2	Moderate	22 48	9820	..	..
3	Great	08 29	3470		..
26	Great	05 38	3930	100	Epicentral region near the Philippine Islands.

MAGNETIC NOTES

Magnetic conditions during May 1943 were slightly less disturbed than in the previous month. There were 13 *quiet* days and 18 days of *slight* disturbance as against 15 quiet days, 15 days of slight disturbance and one of moderate disturbance during May 1942.

The quietest day during May 1943 was the 9th and the day of largest disturbance was the 13th.

The individual days during the month were classified as shown below.

Quiet days	Disturbed days	
	Slight	Moderate
5-10, 20, 22, 23, 26, 29-31.	1-4, 11-19, 21, 24, 25, 27, 28.	Nil.

No magnetic storms occurred during the months of May in the years 1942 and 1943.

The mean character figure for the month of May 1943 was 0·58 as against 0·55 for May of last year. M. V. SIVARAMAKRISHNAN.

We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 65, Nos. 7-10; and Vol. 66, Nos. 1 and 3.

"Agricultural Gazette of New South Wales," Vol. 54, Pts. 3 and 4.

"Indian Journal of Agricultural Science," Vol. 13, Pt. 1.

"Journal of the Indian Chemical Society," Vol. 20, Nos. 3 and 4.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. 15, No. 2.

"Bulletin of the Indian Jute Committee," Vol. 6, No. 2.

"The Review of Applied Mycology," Vol. 22, Pt. 2.

"Bulletin of the American Meteorological Society," Vol. 23, No. 7.

"Journal of Nutrition," Vol. 24, Nos. 4 and 5; Vol. 25, No. 1.

"Indian Trade Journal," Vol. 149, Nos. 1925-27.

BOOKS

The Genetics of the Mouse. By Hans Grüneberg. (Cambridge University Press, Bentley House, London), 1943. Pp. xii + 412. Price 30*sh*.

Intermediate Practical Physics. By Vissa Appa Rao. [Andhra University, Waltair, (Guntur)], 1942. Pp. viii + 337. Price Rs. 4.

Physics and Philosophy. By Sir James Jeans. (Cambridge University Press, London), 1942. Pp. vii + 222. Price 8*sh*. 6*d*.

Elementary Physical Chemistry. By M. Randall and L. E. Young. (Randall and Sons, California), 1942. Pp. xiv + 455. Price $4.50.

Forest Tree Seed, of the North Temperate Regions, with special reference to North America. By H. I. Baldwin. (Waltham, Mass: The Chronica Botanica Co.; Calcutta: Macmillan & Co., Ltd.), 1942. Pp. xvi + 240. Price $4.75.

ERRATA

Vol. 12, No. 5

Page 146, para 3, line 7: *For* 36 commutator segments *read* 18 commutator segments.

Page 155, columns 1 and 2; and page 156, column 2: *For* "$Y = ae^{-b}S$" *read* "$Y = ae^{-bs}$".

Page 157, Note entitled "Inclined Extinction in the Hypersthenes of Charnockites", Fig. 1, tilt zone 212-232 to be cozonal with zone 101-11.

568-43—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the Board of Editors, "Current Science", Bangalore